(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
29 November 2001 (29.11.2001)

PCT

(10) International Publication Number
WO 01/91446 A2

(51) International Patent Classification[7]: H04M 15/00, H04L 12/14

(21) International Application Number: PCT/IB01/00890

(22) International Filing Date: 21 May 2001 (21.05.2001)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:

09/577,152	24 May 2000 (24.05.2000)	US
09/636,738	11 August 2000 (11.08.2000)	US
09/758,267	12 January 2001 (12.01.2001)	US

(71) Applicant: **NOKIA CORPORATION** [FI/FI]; Keilalahdentie 4, FIN-02150 Espoo (FI).

(71) Applicant *(for LC only)*: **NOKIA INC.** [US/US]; 6000 Connection Drive, Irving, TX 75039 (US).

(72) Inventors: **FACCIN, Stefano**; 3421 Dartmoor Drive, Dallas, TX 75229 (US). **HURTTA, Tuija**; Kiskottajankuji 4 D 49, FIN-02660 Espoo (FI). **BERTENYI, Balazs**; 6. Nagyszalonta, H-118 Budapest (HU). **IVANOV, Nedko**; 16 Harang Street, H-1033 Budapest (HU). **HONKO, Harri**; Tuomiokirkonkatu 38 C 17, FIN-33100 Tampere (FI). **KOSKINEN, Juha-Pekka**; Heinajoenkatu 13, FIN-13210 Hameenlinna (FI). **VALLINEN, Juha**; Lentokentantie 26, FIN-33900 Tampere (FI). **HOPEAHARJU, Merja**; Halimajarventi 32, FIN-36100 Kangasala (FI).

(74) Agents: **BRUNDIDGE, Carl, I.** et al.; Antonelli, Terry, Stout & Kraus, LLP, Suite 1800, 1300 N. Seventeenth Street, Arlington, VA 22209 (US).

(81) Designated States *(national)*: CN, JP, LC.

(84) Designated States *(regional)*: European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR).

Published:

— *without international search report and to be republished upon receipt of that report*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: COMMON CHARGING IDENTIFIER FOR COMMUNICATION NETWORKS

(57) Abstract: In a first embodiment of the invention, when an Activate PDP Context Request message is forwarded to a Service GPRS Support Node (SGSN), the SGSN creates a Create PDP Context Request message and forwards it to a Gateway GPRS Support Node (GGSN). In response to the Create PDP Context Request forwarded by the SGSN, the GGSN creates a Create PDP Context Response message. When a PDP context is created by the GGSN, the GGSN associates a Globally Unique Charging Identification (GCI) with the PDP context. Then, the Create PDP Context Response including the GCI is forwarded to the SGSN. The GCI is sent from the SGSN to the UE and from the UE to the CSCF. In a second embodiment of the invention, the GCI is sent from the SGSN or the GGSN directly to the Call State Control Function (CSCF). Sending the GCI can be performed either autonomously or based on a request from the CSCF. In either embodiment, the CSCF can send the GCI to a second network which performs processing, such as billing, from data collected from call detail records associated with the GCI.

WO 01/91446 A2

COMMON CHARGING IDENTIFIER FOR COMMUNICATION NETWORKS

TECHNICAL FIELD

The present invention relates to communication networks and, more particularly, the present invention relates to techniques for charging coordination and other kinds of information coordination, and a common charging identifier for communication networks.

BACKGROUND ART

In general, packet switched wireless networks provide communications for mobile terminals with no physical connection required for network access. The General Packet Radio Service (GPRS) in the Global System for Mobile Communications (GSM) and the Universal Mobile Terrestrial System (UMTS) have both been developed to provide wireless communications networks with a packet switched side, as well as a circuit switched side.

The specifications for UMTS networks with further improvements have been released by the 3rd Generation Partnership Program (www.3gpp.org). Release 00 of the UMTS specifications provides that a network subscriber can have one or more packet data protocol (PDP) addresses. Each PDP address is described by one or more PDP contexts in the Mobile Terminal (MT), the Service GPRS Support Node (SGSN), and the Gateway GPRS Support Node (GGSN). The GGSN is a gateway to external networks. Each PDP context may have routing and mapping information for directing the transfer of data to and from its associated PDP address and a traffic flow template (TFT) for filtering the transferred data.

Each PDP context can be selectively and independently activated, modified, and deactivated. The activation state of a PDP context indicates whether data transfer

is enabled for a corresponding PDP address and TFT. If all PDP contexts associated with the same PDP address are inactive or deactivated, all data transfer for that PDP address is disabled. All PDP contexts of a subscriber are associated with the same Mobility Management (MM) context for the International Mobile Subscriber Identity (IMSI) of that subscriber. Setting up a PDP context means setting up a communication channel.

FIG. 1 is a process flow diagram that illustrates an example of the PDP context activation procedure. In step 100, the MT sends an Activate PDP Context Request to the SGSN. The Activate PDP Context Request message sent in step 100 includes a number of parameters. The parameters include a PDP address and an Access Point Name (APN). The PDP address is used to indicate whether a static PDP or dynamic PDP address is required. The APN is a logical name referring to the Gateway GPRS Support Node (GGSN) to be used.

In step 102, the SGSN sends a Radio Access Bearer (RAB) setup message to the UMTS Terrestrial Radio Access Network (UTRAN) or the GERAN or other corresponding radio access networks . In step 104, the SGSN sends a Create PDP Context Request message to the affected GGSN. The GGSN decides whether to accept or reject the request. If it accepts the request, it modifies its PDP context table and returns a Create PDP Context Response message in step 106. The SGSN then sends an Activate PDP Context Accept message to the Mobile Terminal in step 108.

In Release 00 of the Universal Mobile Telecommunications System specifications (UMTS), a new architecture with existing and new logical entities is introduced to support IP multimedia services including, e.g., IP telephony. SIP (Session Initiation Protocol) is used for call control. The caller allocates a Call Id, which is included in SIP messages. The Call Id uniquely identifies the call and is used by all call participants However, the use of the Call ID is complicated in the case of a mobile station (MS) comprised of mobile terminal (MT) and terminal equipment (TE) parts since the MT driver in the TE is preferably able to filter the UDP/IP packets

forwarded to the MT, and be able to parse the majority if not the entire SIP grammar to find the Call-ID field contained somewhere in a UDP datagram.

The subscribers of voice services are accustomed to receiving bills based on calls, not based on the transport resources used for making the calls. Subscribers of IP telephony often expect similar billing criteria. Consequently, billing for the services used (e.g., for the calls) rather than the transport resources used is becoming increasingly important. In the case of Wireless Application Protocol (WAP) services, billing for services rather than transport resources is already the expectation.

For an IP telephony call, a PDP context is required to carry the actual voice traffic. Both the GPRS/UMTS layer and the IP telephony layer collect charging information (CDRs): the GPRS/UMTS layer collects charging information for the PDP context while the IP telephony layer collects charging information for the call. A common identifier ought to be added to the CDRs to make it possible to bill based only on the CDRs created by the IP telephony layer (i.e., for services) and to omit the CDRs created by the GPRS/UMTS layer (i.e., for transport resources).

A common identifier is needed in the CDRs created by the GPRS/UMTS layer and by the IP telephony layer to make it possible to omit certain CDRs and enable billing based on services rather than use of transport resources. More specifically, in many cases it would be advantageous to selectively omit CDRs created by the GPRS/UMTS layer or CDRs created by the IP telephony layer. If that were possible, the billing would be operator-specific, in that the operator could decide how to bill the subscribers (how to use the created CDRs).

In spite of the numerous details provided in the aforementioned protocol, many features associated with mobile networks have not been dealt with. Specifically, charging information can be created by the SGSN, the GGSN and by the IP telephony network elements, e. g. the CSCF. At present there is no solution in place to associate the charging information created by the SGSN, the GGSN and the charging information created by the CSCF. Indeed, the network may be so

complicated (e.g., the charging data may be generated in many different network elements) that it is not possible to combine all call event related data. At least some of this data is needed in order to implement network functionality such as hot billing or merely to allow a network operator to implement joint billing for GPRS services and IP telephony services.

DISCLOSURE OF THE INVENTION

According to a first illustrative embodiment of the invention, when an Activate PDP Context Request message is forwarded to a Service GPRS Support Node (SGSN) by an MT, the SGSN creates a Create PDP Context Request message and forwards it to a Gateway GPRS Support Node (GGSN). In response to the Create PDP Context Request forwarded by the SGSN, the GGSN creates a Create PDP Context Response message. When a PDP context is created by the GGSN, the GGSN associates a Charging Identification parameter with the PDP context. Then, the Create PDP Context Response including the Charging Identification parameter is forwarded to the SGSN. In response to the PDP Context Response forwarded by the GGSN to the SGSN, the SGSN forwards an Activate PDP Context Accept message to the MT. According to the first embodiment of the invention, both the Charging Identification parameter and possibly the GGSN address are provided to the MT in the Activate PDP Context Accept message. As described herein, the mobile station (MS) includes two parts: the terminal equipment (TE) and the mobile terminal (MT). The MS may also be referred to as user equipment (UE). The TE can, e.g., be a laptop which is then connected to the MT. The MT can be a mobile phone.

Sending the GGSN address is not mandatory. Another alternative is that the CSCF adds the IP address of the MS to the charging records (CDRs) that it creates for a call. The SGSN and the GGSN already add the PDP address of the PDP context to the CDRs. By checking that the PDP address is the same as the IP address, it can be ensured that the PDP context has been used for the call in question. Since this

requires that the charging identifications are the same, the CSCF adds the Charging Identification to the CDRs that it creates for the call in question.

According to a second illustrative embodiment of the invention, the Charging Identification can be sent from the SGSN or the GGSN to the Call State Control Function (CSCF). When an Activate PDP Context Request message is forwarded to the SGSN, the SGSN creates a Create PDP Context Request message. The SGSN sends the Create PDP Context Request to the GGSN. In response to the Create PDP Context Request received from the SGSN, the GGSN creates a Create PDP Context Response. The GGSN associates the Charging Identification parameter with the PDP context. The Create PDP Context Response including the Charging Identification parameter is then forwarded to the SGSN.

The Charging Identification parameter can be sent from either of the SGSN or the GGSN directly to the CSCF; and, such sending of the Charging Identification parameter can be performed either autonomously, e.g., at PDP context activation, or based on a request from the CSCF.

In a specific embodiment, the CSCF sends the charging identification towards an endpoint of a communication, and sends security information together with said charging identification toward the endpoint. The CSCF is able to send an address of a GGSN together with the charging identification to the endpoint. If the GGSN address is not sent with the charging identification, the CSCF adds the IP address of the mobile station (UE) to the CDRs.

In a variation of the first and second illustrative embodiments, the Charging Identification parameter is a Globally Unique Charging Identification (GCI). (Although referred to in this application as "globally" unique, the charging identification need only be utilized by as few as only two networks.) The GCI is used during a call to ease combination of call event related data from different network elements. One particular feature of the embodiment is that the GCI can be generated by any network element. It can be generated by the SGSN, GGSN or CSCF. Such a

network element can be a 2nd generation network element or a 3rd generation network element. In any event, the network elements (other than the network element which generated the GCI) do not need to generate a charging identification, but instead use the GCI generated by the other network element. The GCI can be used to ease combination of all call event related data or any portion thereof. As an example, the GCI and all the charging data for a call event can be collected and used by another network, such as one including a post-processing system providing billing for network subscribers.

The principles of the invention are applicable to other types of communication channels in addition to PDP contexts.

For an IP telephony call, a PDP context is required to carry the actual voice traffic. Both the GPRS/UMTS layer and the IP telephony layer collect charging information (CDRs): The GPRS/UMTS layer collects charging information for the PDP context while the IP telephony layer collects charging information for the call. According to a third illustrative embodiment of the invention, a common identifier is added to the CDRs, which, for example, makes it possible to bill based on the CDRs created by the IP telephony layer (i.e., for services) and omit the CDRs created by the GPRS/UMTS layer (i.e., for transport resources).

According to the principles of the third embodiment of the invention, the common identifier is associated with the CDRs created by the GPRS/UMTS layer and by the IP telephony layer. The common identifier enables charging coordination and other kinds of information coordination.

A call in SIP is identified by the Call Identification which is used as the common identifier. The Call Identification is allocated by the caller and included in the SIP messages. The MS sends the SIP messages to the called party via the CSCF. The CSCF intercepts the SIP messages and can thereby obtain the Call Identification from the SIP messages.

To use the Call Identification for charging coordination or other kinds of information coordination in accordance with the principles of the invention, the MS sends the Call Identification to the SGSN and the GGSN during PDP context activation. More specifically, the MS sends the Call Identification to the SGSN along with the Activate (Secondary) PDP Context Request message, and the SGSN forwards the Call Identification to the GGSN along with the Create PDP Context Request message.

The process described herein works for both mobile-originated calls (where the MS allocates the Call Identification) and mobile-terminated calls (where the MS receives the Call Identification in the SIP Invite message). According to the process described herein, the SGSN and the GGSN add the Call Identification to the CDRs that they create for the PDP context, and the CSCF adds the Call Identification to the CDRs that it creates for the call.

A fourth embodiment of the invention is similar to the third embodiment, except that a unique identifier is formed by using the UDP port number present in the SDP syntax of SIP "INVITE" and "183 Session Progress" messages instead of the Call-ID field.

In either of these embodiments, an operator is given greater flexibility in deciding how to bill subscribers for the created CDRs. The operator can selectively omit billing for CDRs created by the GPRS/UMTS layer while choosing to bill for CDRs created by the IP telephony layer.

Other aspects and advantages of the invention will become apparent from the following detailed description and accompanying drawings, illustrating by way of example the features of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing and a better understanding of the present invention will become apparent from the following detailed description of example embodiments and the

claims when read in connection with the accompanying drawings, all forming a part of the disclosure of this invention. While the foregoing and following written and illustrated disclosure focuses on disclosing example embodiments of the invention, it should be clearly understood that the same is by way of illustration and example only and the invention is not limited thereto. The spirit and scope of the present invention are limited only by the terms of the appended claims.

FIG. 1 is a generalized process flow diagram illustrating the PDP context activation procedure.

FIG. 2 is a generalized block diagram of the architecture of a packet switched wireless communication network in which the example embodiments of the invention can be practiced.

FIG. 3 is a generalized process flow diagram illustrating sending a charging identification in accordance with a first embodiment of the present invention.

FIG. 4 is a generalized process flow diagram illustrating sending a charging identification in accordance with an arrangement of a second embodiment of the present invention.

FIG. 5 is a generalized process flow diagram illustrating sending a charging identification in accordance with another arrangement of the second embodiment of the invention.

FIG. 6 is a generalized process flow diagram illustrating sending a call identification in accordance with a third embodiment of the invention.

FIG. 7 is a generalized signaling flow diagram illustrating coordination of the application layer and transport layer in accordance with an arrangement of the third embodiment of the invention.

FIG. 8 is a generalized signaling flow diagram illustrating coordination of the application layer and transport layer in accordance with another arrangement of the third embodiment of the invention.

FIG. 9 is a generalized process flow diagram illustrating sending a tuple or

tuple pair in accordance with a fourth embodiment of the invention.

FIG. 10 is a generalized signaling flow diagram illustrating coordination of the application layer and transport layer in accordance with an arrangement of the third embodiment of the invention.

FIG. 11 is a generalized signaling flow diagram illustrating coordination of the application layer and transport layer in accordance with another arrangement of the fourth embodiment of the invention.

BEST MODE FOR CARRYING OUT THE INVENTION

Before beginning a detailed description of the subject invention, mention of the following is in order, when appropriate, like reference numerals and characters may be used to designate identical, corresponding, or similar components in differing drawing figures. Furthermore, in the detailed description to follow, example sizes/models/values/ranges may be given, although the present invention is not limited thereto.

An example of a network architecture supporting these specifications is the wireless communications network shown in the block diagram of FIG. 2. The various elements of the network and their functions are described in the General Packet Radio Service (GPRS) Service Description, Stage 2, 3GPP TS 23.060, published by the 3rd Generation Partnership Program (www.3gpp.org). The elements and their functions may be described in earlier or later versions of the 3GPP TS 23.060 specifications or may be those of any other known packet switched wireless communications network. The description of network elements and their functions are merely a non-limiting example of packet switched wireless communication networks.

Several elements of the example network illustrated in FIG. 2 are particularly relevant to this invention. The Mobile Terminal (MT), commonly referred to as a cell phone or a mobile phone, is only one possible part of User Equipment (UE). Typically, Terminal Equipment (TE), used together with a Mobile Terminal (MT),

constitutes User Equipment (UE), which is also referred to as a Mobile Station (MS). Any UE may be utilized in conjunction with this invention so that it operates or can be programmed to operate in the manner described below. The UMTS Terrestrial Radio Access Network (UTRAN) and the Base Station System (BSS) in GPRS manage and control the radio access between the core network and a number of MTs. There are also other possible radio access networks like GERAN.

The CSCF is a network element in an IP telephony network. The IP telephony network is sometimes referred to as "the application layer". The structure and function of the Call State Control Function (CSCF) can be divided into several logical components, which are currently internal to the CSCF. Every CSCF acting as a Serving CSCF has a Call Control Function (CCF) function. The CSCF includes an ICGW (Incoming call gateway). The ICGW acts as a first entry point. The ICGW performs routing of incoming calls. Incoming call service triggering (e.g. call screening /call forwarding unconditional) may need to reside for optimization purposes. The ICGW performs Query Address Handling (implies administrative dependency with other entities); and communicates with the Home Subscriber Server (HSS).

The CCF (Call Control Function) performs call set-up/termination and state/event management; interacts with MRF in order to support multi-party and other services; reports call events for billing, auditing, intercept or other purposes; receives and process application layer registration; performs query address handling (implies administrative dependency); and may provide service trigger mechanisms (service capabilities features) towards application & services network (VHE/OSA). The CCF may invoke location based services relevant to the serving network, and may check whether the requested outgoing communication is allowed given the current subscription.

The CSCF includes a SPD (Serving Profile Database). The SPD interacts with HSS in the home domain to receive profile information for the R00 all-IP network

user and may store them depending on the SLA with the home domain. The SPD notifies the home domain of initial user's access (which includes, e.g., CSCF signaling transport address, user ID, etc.) The SPD may cache access related information (e.g. terminal IP address(es) where the user may be reached, etc.)

The CSCF performs AH (Address Handling) function. The AH function includes analysis, translation, modification, if required, address portability, and mapping of alias addresses. The AH function may do temporary address handling for inter-network routing.

The Serving GPRS Support Node (SGSN) is the node that serves the MT. At PDP context activation, the SGSN establishes a PDP context used for routing purposes. The Gateway GPRS Support Node (GGSN) is the node accessed by the external packet data network due to evaluation of the PDP address. It contains routing information for attached GPRS/UMTS users. The routing information is used to tunnel Protocol Data Units (PDUs) to the SGSN. The SGSN and GGSN functionalities may reside in different physical nodes or may be combined in the same physical node, for example, the Internet GPRS Support Node (IGSN).

The IP-based mobile network architecture includes an application layer and a transport layer. The transport layer protocols and mechanisms are usually optimized for the specific type of access whereas the application layer is normally generic, that is independent of the type of access.

In IP-based mobile networks, the UE sets up a call by signaling to the peer entity and exchanging messages of a call control protocol over an IP connection provided by the transport layer. In setting up a call in the application layer, the underlying transport layer has to set up the transport bearers over the radio interface and in the transport network. For an IP-based mobile network, setting up of transport bearers means allocating radio resources and network resources. The call control signaling is transparently exchanged over an IP connection provided by the transport layer.

Embodiment 1

FIG. 3 illustrates a process of sending a charging identification in accordance with a first embodiment of the present invention. In UMTS all-IP networks, when GPRS/UMTS is adopted as access/transport network for multimedia and voice over IP services, charging will be performed independently at the GPRS/UMTS layer and at the application layer (e.g., the CSCF).

In the GPRS and UMTS networks, PDP contexts are created by the GGSN upon request from the SGSN (with a Create PDP Context Request message) that, in turn, receives the request from the MT (an Activate PDP Context Request message).

As illustrated in FIG. 3, the technique in accordance with the present invention begins at the application layer at step 300 in which a trigger is forwarded from the TE (Terminal Equipment) to the MT (Mobile Terminal). The trigger may be, e.g., a call set up indication including the requested logical channels and characteristics, sent from the TE to the MT to start PDP context activation.

At step 302, an Activate PDP Context Request message is forwarded to the SGSN. In response thereto, in step 304, the SGSN creates a Create PDP Context Request message and forwards it to the GGSN. In response to the Create PDP Context Request forwarded by the SGSN, in step 306, the GGSN creates a Create PDP Context Response message.

In step 308, when a PDP context is created by the GGSN, the GGSN associates a Charging Identification parameter with the PDP context in step 308. Then, in step 310, the Create PDP Context Response message including the Charging Identification parameter is forwarded to the SGSN.

In turn, in response to the PDP Context Response forwarded by the GGSN to the SGSN, in step 312, the SGSN forwards an Activate PDP Context Accept message to the MT. According to the first embodiment of the invention, both the Charging Identification parameter and the GGSN Address are provided to the MT in the Activate PDP Context Accept message.

The above noted procedures in steps 300-312 are repeated as many times as needed depending on the PDP contexts needed.

Upon the completion of the last procedure in step 312, the UE forwards a call set up message, including requested logical channels and characteristics, to the CSCF (Call State Control Function) in step 314. The MT will, in turn, provide the Charging Identification and the GGSN Address to the CSCF within the call set up message. The CSCF, in turn, forwards the call set up message, including requested logical channels and characteristics, to the remote end point in step 316. The remote end point then forwards a response message, including accepted logical channels and characteristics, back to the CSCF in step 318. The CSCF then forwards the response message, including accepted logical channels and characteristics, to the UE in step 320. The response message may be, e.g., the Connect message in H.323 or a SIP response message, but not necessarily limited to those.

The invention contemplates that the Charging Identification parameter can be made more secure by applying appropriate cryptographic algorithms to avoid a false Charging Identification being forwarded by a malicious MT to the CSCF instead of the legitimate value, or a malicious MT re-using a value of the Charging Identification.

From the foregoing, it will be appreciated that in the first embodiment of the invention, the Charging Identification parameter is sent from the SGSN to the UE and from the UE to the CSCF.

Embodiment 2

FIG. 4 illustrates a process of sending a charging identification in accordance with an arrangement of a second embodiment of the present invention. In UMTS all-IP networks, when GPRS/UMTS is adopted as the access/transport network for multimedia and voice over IP services, charging will be performed independently at the GPRS/UMTS layer and at the application layer (e.g., the CSCF).

In the GPRS and UMTS networks, PDP contexts are created by the GGSN upon request from the SGSN (i.e., a Create PDP Context Request message) that, in turn, receives the request from the MT (i.e., an Activate PDP Context Request). According to the second embodiment of the invention, the Charging Identification parameter is sent from the SGSN or the GGSN to the CSCF. Unlike the first embodiment, there is no need to send the Charging Identification parameter via the UE.

As described previously, in the first embodiment of the invention, the MT intercepts data packets that are sent from the TE and adds the Charging Identification parameter to a specific data packet (the SIP message or the H.323 message for call set up). Interception of data packets may decrease the performance of the MT.

In the second embodiment of the invention, the GPRS/UMTS and IPT network elements are able to coordinate charging information or other kinds of information, e.g., in order to combine charging information collected for a PDP context by the SGSN and the GGSN and for a call by the CSCF.. Like the first embodiment, the GGSN allocates a Charging Id parameter at PDP context activation. And like the first embodiment, the GGSN sends the Charging Id parameter to the SGSN. But, unique to the second embodiment, the Charging Identification, possibly together with other information (e.g., IMSI, MSISDN, PDP address, UE port number from the TFT, Charging Characteristics etc.) can be sent from the SGSN or the GGSN to the CSCF.

Sending the Charging Id parameter can be performed either autonomously or based on a request from the CSCF. The SGSN will send the Charging Identification, since the address of the CSCF has to be known if something will be sent to it. The SGSN has an interface with the HSS (HLR+UMS), which contains the address of the serving CSCF.

There also can be an interface between the GGSN and the CSCF. This new interface could then be used to carry the Charging Id and possibly other charging

related information. FIG. 4 illustrates an aspect of the second embodiment of the invention in which the SGSN sends the Charging-Id parameter to the CSCF.

As illustrated in FIG. 4, a process of sending a charging identification in accordance with the present invention begins at step 400 in which a trigger is forwarded from the TE (Terminal Equipment) to the MT (Mobile Terminal). The trigger may be, e.g., a call set up message including the requested logical channels and characteristics.

At step 402, an Activate PDP Context Request message is forwarded to the SGSN. In response thereto, in step 404, the SGSN creates a Create PDP Context Request message.

In step 406, the SGSN sends the Create PDP Context Request to the GGSN. In response to the Create PDP Context Request received from the SGSN, in step 408, the GGSN creates a Create PDP Context Response. In step 410, the GGSN associates the Charging Identification parameter with the PDP context. In step 412, both the Create PDP Context Response and the Charging Identification are then returned to the SGSN in the Create PDP Context Response message.

The Charging Id is included in the CDRs created by the GGSN and the SGSN. The CDRs are sent to the Charging Gateway Functionality (CGR) for further processing. From the Charging Gateway Functionality, the CDRs are sent to the Billing System. This is true for all the embodiments. In addition, it is important that the CSCF adds the Charging Id to the CDRs that it creates for the call in question. The CSCF sends CDRs either to the Charging Gateway Functionality (CGF) or to the Billing System. This way, when creating a bill for a subscriber, the PDP context(s) that were used for a specific call can be checked. The Charging Identification in all those CDRs is the same.

If the Charging Characteristics change during an active PDP context, the SGSN includes the new Charging Characteristics of the PDP context in an Update PDP Context Request message, which the SGSN sends to the GGSN.

According to this arrangement of the second embodiment, the Charging Id parameter, possibly together with other information (e.g., IMSI, MSISDN, PDP address, UE port number from the TFT, Charging Characteristics etc.), is sent from the SGSN directly to the CSCF in step 414. This is done either autonomously (in a first case) or based on a request from the CSCF (in a second case).

In the first case, at PDP context activation (and modification), the SGSN sends a message including the Charging Id and possibly other information (see above) to the CSCF. The message sent by the SGSN may be acknowledged by the CSCF.

The SGSN must know the CSCF address. The CSCF address may be requested from the HSS or may be derived from the TFT which the UE specifies for the PDP context which is used for the communication with the CSCF.

In the second case, at call set up, the CSCF requests information from the SGSN. The request is based, e.g., on IMSI or MSISDN. The SGSN sends the Charging Id and possibly other information (see above) to the CSCF.

The CSCF must know the SGSN address. The SGSN address may be requested from the HSS.

The CSCF, in turn, forwards the call set up message to the remote end point in step 416. The remote end point then forwards a response message back to the CSCF in step 418. The CSCF then forwards the response message to the UE in step 420.

FIG. 5 illustrates another arrangement of the second embodiment of the invention in which the GGSN sends the Charging Identification directly to the CSCF. Referring to FIG. 5, a process of sending a charging identification in accordance with the present invention begins at step 500 in which a trigger is forwarded from the TE to the MT (Mobile Terminal). The trigger may be, e.g., a call set up message including the requested logical channels and characteristics.

At step 502, an Activate PDP Context Request message is forwarded to the SGSN. In response thereto, in step 504, the SGSN creates a Create PDP Context Request message. In step 506, the SGSN sends the Create PDP Context Request to

the GGSN.

In response to the Create PDP Context Request received from the SGSN, in step 508, the GGSN creates a Create PDP Context Response. In step 510, the GGSN associates the Charging Identification parameter with the PDP context. In step 512, the Create PDP Context Response message including the Charging Identification is then returned to the SGSN.

According to this aspect of the second embodiment, the Charging Id parameter, possibly together with other information (e.g., IMSI, MSISDN, PDP address, UE port number from the TFT, Charging Characteristics etc.), is sent from the GGSN directly to the CSCF in step 514. Step 514 is performed either autonomously (in a first case) or based on a request from the CSCF (in a second case).

In the first case, at PDP context activation (and modification), the GGSN sends a message including the Charging Id and possibly other information (see above) to the CSCF. The message sent by the GGSN may be acknowledged by the CSCF.

The GGSN needs to know the CSCF address. The CSCF address may be requested from the HSS or may be derived from the TFT which the UE specifies for the PDP context that is used for the communication with the CSCF.

In the second case, at call set up, the CSCF requests information from the GGSN. The request is based, e.g., on IMSI or MSISDN. The GGSN sends the Charging Id parameter and possibly other information to the CSCF.

The CSCF forwards the call set up message to the remote end point in step 516. The remote end point then forwards a response message back to the CSCF in step 518. The CSCF then forwards the response message to the UE in step 520.

The second embodiment allows the GPRS and IPT network elements to coordinate charging information and other kinds of information, e.g., in order to combine charging information collected for a PDP context by the SGSN and the GGSN and for a call by the CSCF. Sending the Charging Identification from the

SGSN or the GGSN to the CSCF requires an interface between the application layer network and the transport layer network.

Variation of Embodiments 1 and 2

In a variation of the first and second embodiments, the Charging Identification generated in the SGSN, GGSN or other network element is a Globally Unique Charging Identification (GCI). The GCI is a combination of the integer value $2\wedge32-1$ (4 bytes) and the ID of the network element which generated it (such as the SGSN or GGSN). The length or structure of the network element ID generating the GCI may vary according to the specific implementation. It is not necessary that the GCI be generated in any particular group of network elements. In any circumstance, the remaining network elements simply receive and use the GCI generated by the first network element.

After the GCI is generated, it is used during the entire call and the other network elements don't generate a charging identification, but instead use the GCI generated by the first network element. The GCI is created and transferred over several interfaces in the place of the Charging Identification described above. A plurality of separate call detail records (CDRs) can be generated and associated with each other using the GCI. For example, the SGSN may create a S-CDR and the GGSN may create a G-CDR as explained in 3G TS 32.015. The CSCF (together with a MGCF) may create a C-CDR. A terminating network (such as a PSTN/MSC) may create POC and MTC CDRs.

When an endpoint (such as a MGCF) receives the GCI passed from the CSCF, it may pass it on to another network. Preferably, the GCI can be transferred to, within and between 2nd generation ("2G") networks as well as the 3G network described above. The SIP and GTP' protocols may be used to carry the GCI in the 3G network as described above, and the corresponding protocols in a 2G network may be modified

so that they can also carry the GCI. As an example, the connected 2G network may be a post-processing system which produces subscriber billing by effectively using the GCI to determine and combine charging data for the subscriber in one or more CDRs.

Embodiment 3

The subscribers of voice services are accustomed to receiving bills based on calls, not based on the transport resources used for making the calls. Subscribers of IP telephony often expect similar billing criteria. Consequently, billing for the services used (e.g., for the calls) rather than the transport resources used is becoming increasingly important. In the case of WAP services, billing for services rather than transport resources is already the expectation.

For an IP telephony call, a PDP context is required to carry the actual voice traffic. Both the GPRS/UMTS layer and the IP telephony layer collect charging information (CDRs): The GPRS/UMTS layer collects charging information for the PDP context while the IP telephony layer collects charging information for the call. A common identifier ought to be added to the CDRs to make it possible, for example, to bill based only on the CDRs created by the IP telephony layer (i.e., for services) and to omit the CDRs created by the GPRS/UMTS layer (i.e., for transport resources).

A common identifier is needed in the CDRs created by the GPRS/UMTS layer and by the IP telephony layer to make it possible to omit certain CDRs and enable billing based on services rather than use of transport resources. More specifically, in many cases it would be advantageous to selectively omit CDRs created by the GPRS/UMTS layer or CDRs created by the IP telephony layer. If that were possible, the billing would be operator-specific, in that the operator could decide how to bill the subscribers (how to use the created CDRs).

According to the principles of the invention, a common identifier is associated with the CDRs created by the GPRS/UMTS layer and by the IP telephony layer. The

common identifier enables charging coordination and other kinds of information coordination.

Instead of using a GGSN-allocated Charging Identification, a call in SIP is identified with a Call Identification, which is used as a charging coordinator. The Call Identification is allocated by the caller and included in the SIP messages. The MS sends the SIP messages to the called party via the CSCF. The CSCF intercepts the SIP messages and can thereby obtain the Call Identification from the SIP messages.

To use the Call Identification for charging coordination or other kinds of coordination in accordance with the principles of the invention, the MS sends the Call Identification to the SGSN and the GGSN during PDP context activation. More specifically, the MS sends the Call Identification to the SGSN along with the Activate (Secondary) PDP Context Request message, and the SGSN forwards the Call Identification to the GGSN along with the Create PDP Context Request message.

FIG. 6 illustrates a process for coordinating charging in accordance with a third embodiment of the invention, which advantageously enhances coordination of information between transport and application layers. As illustrated in FIG. 6, the technique in accordance with the present invention begins at the application layer at step 600 in which a trigger is forwarded from the TE (Terminal Equipment) to the MT (Mobile Terminal). The trigger may be, e.g., a call set up indication including the requested logical channels and characteristics, sent from the TE to the MT to start PDP context activation. In step 602, the MS initiates a transaction in the form of a call. In step 604, the MS assigns a call identification to the call. The process described herein works for mobile-originated calls (where the MS allocates the Call Identification), as described subsequently with respect to FIG. 7, and also for mobile-terminated calls (where the MS receives the Call Identification in the SIP Invite message), as described subsequently with respect to FIG. 8. In step 606, the call identification is sent from the MS to the CSCF.

In step 608, an Activate (Secondary) PDP Context Request message and a Call Identification is forwarded from the MS to the SGSN. In step 610, the SGSN sends a Radio Access Bearer (RAB) setup message to the UTRAN. In response thereto, in step 612, the SGSN creates a Create PDP Context Request message and forwards it to the GGSN along with the Call Identification. In response to the Create PDP Context Request forwarded by the SGSN, in step 614, the GGSN creates a Create PDP Context Response message.

In step 616, the Create PDP Context Response message is forwarded to the SGSN. In response to the PDP Context Response forwarded by the GGSN to the SGSN, in step 618, the SGSN forwards an Activate (Secondary) PDP Context Accept message to the MS.

According to the process described herein, the SGSN and the GGSN add the Call Identification to the CDRs that they create for the PDP context, and the CSCF adds the Call Identification to the CDRs that it creates for the call.

Accordingly, an operator is given greater flexibility in deciding how to bill subscribers for the created CDRs. The operator can selectively omit billing for CDRs created by the GPRS/UMTS layer while choosing to bill for CDRs created by the IP telephony layer.

FIG. 7 is a signaling flow diagram illustrating coordination of the application layer and transport layer in accordance with an arrangement of the third embodiment of the invention. To enable charging coordination or other kinds of information coordination for a mobile-originated call, the Call Id is sent to the CSCF at call set up and to the SGSN and to the GGSN at PDP context activation. With reference to FIG. 7, at 700, the MS allocates a Call Id and sends it to the CSCF in the SIP Invite message. At 702, the MS activates at least one PDP context for the call. The MS sends the Call Id to the SGSN in the Activate (Secondary) PDP Context Request message. If multiple PDP contexts are activated for the call, the MS has to send the Call Id to the SGSN at every PDP context activation. At 704, the radio access bearer

setup is performed. At 706, the SGSN sends the Call Id to the GGSN in the Create PDP Context Request message. At 708 and 710, the (secondary) PDP context activation is accepted.

FIG. 8 is a signaling flow diagram illustrating coordination of the application layer and transport layer in accordance with another arrangement of the third embodiment of the invention. FIG. 8 presents an example of charging coordination for a mobile-terminated call. With reference to FIG. 8, at 800 the MS receives the SIP Invite message. The caller has allocated the Call Id for the call. At 802, the MS activates at least one PDP context for the call. The MS sends the Call Id to the SGSN in the Activate (Secondary) PDP Context Request message. If multiple PDP contexts are activated for the call, the MS has to send the Call Id to the SGSN at every PDP context activation. At 804, the radio access bearer setup is performed. At 806, the SGSN sends the Call Id to the GGSN in the Create PDP Context Request message. At 808 and 810, the (secondary) PDP context activation is accepted.

Embodiment 4

In another embodiment similar to Embodiment 3 described above, the common identifier associated with the CDRs created by the GPRS/UMTS layer and by the IP telephony layer is a tuple or tuple pair used to differentiate connections in IP networking. A "tuple" consists of the IP address and UDP port values related to the RTP data flow of the connection. A "tuple pair" consists of the tuples for both the source and destination side connection endpoints. To use the tuple or tuple pair for charging coordination or other kinds of information coordination in accordance with the principles of the invention, the MS sends them to the SGSN and the GGSN during PDP context activation. More specifically, the MS sends them to the SGSN along with the Activate (Secondary) PDP Context Request message, and the SGSN forwards them to the GGSN along with the Create PDP Context Request message.

The process for coordinating charging in accordance with this fourth embodiment of the invention is illustrated in FIG. 9. At step 900, a trigger is forwarded from the TE (Terminal Equipment) to the MT (Mobile Terminal). The trigger may be, e.g., a call set up indication including the requested logical channels and characteristics, sent from the TE to the MT to start PDP context activation. In step 902, the MS initiates a transaction in the form of a call. In step 904, the MS assigns the tuple for each proposed media flow it suggests to use within the call. This information will then be carried in the SDP part of SIP INVITE and be used as destination tuple by the remote endpoint, if the remote endpoint agrees to use the proposed media. The process described herein works for mobile-originated calls (where the MS allocates the UDP/IP tuple values), as described subsequently with respect to FIG. 9, and also for mobile-terminated calls (where the MS receives the tuple in the SIP INVITE message), as described subsequently with respect to FIG. 9. In step 906, the tuple is sent from the MS to the CSCF.

In step 908, the media negotiation has traversed the necessary round-trips through the CSCF signalling chain and the terminating MS knows at least the initially agreed destination and source connection tuples (a tuple pair) for each media flow. Preferably, the P-CSCF of both the originating and terminating terminals parse and grab the tuple pair values from passing SIP messages (for media authorization and policy control purposes). An Activate (Secondary) PDP Context Request message and the connection specific tuple pair information is forwarded from the MS to the SGSN. In step 910, the SGSN sends a Radio Access Bearer (RAB) setup message to the UTRAN. In response thereto, in step 912, the SGSN creates a Create PDP Context Request message and forwards it to the GGSN along with the tuple pair. In response to the Create PDP Context Request forwarded by the SGSN, in step 914, the GGSN creates a Create PDP Context Response message.

In step 916, the Create PDP Context Response message is forwarded to the SGSN. In response to the PDP Context Response forwarded by the GGSN to the

SGSN, in step 918, the SGSN forwards an Activate (Secondary) PDP Context Accept message to the MS.

According to the process described herein, the SGSN and the GGSN add the tuple pair to the CDRs that they create for the PDP context, and the CSCF adds the tuple pair present in media specific part (e.g., SDP) of SIP signalling to the CDRs that it creates for the call.

Accordingly, an operator is given greater flexibility in deciding how to bill subscribers for the created CDRs. The operator can selectively omit billing for CDRs created by the GPRS/UMTS layer while choosing to bill for CDRs created by the IP telephony layer.

FIG. 10 is a signaling flow diagram illustrating coordination of the application layer and transport layer in accordance with an arrangement of the fourth embodiment of the invention. To enable charging coordination or other kinds of information coordination for a mobile-originated call, the tuple or tuple pair is sent to the CSCF at call set up and to the SGSN and to the GGSN at PDP context activation. With reference to FIG. 10, at 1000, the MS allocates a tuple for each proposed media flow it suggests to use within the call. This information will then be carried in a media specific (e.g., SDP) part of SIP INVITE and be used as destination tuple by the remote endpoint, if it agrees to use the proposed media. MS sends the tuples for each proposed media flow to the CSCF in the SIP INVITE message. Prior to this signalling, the MS activates at least one (signalling) PDP context for the call if one is not already activated. After the media negotiation has traversed the necessary round-trips through the CSCF signalling chain and both originating and terminating terminal know the at least initially agreed destination and source connection tuples (a tuple pair) for each media flow, the MS sends the connection specific tuple pair to the SGSN in the Activate (Secondary) PDP Context Request message. If multiple PDP contexts (multiple media) are activated for the call, the MS has to send the tuple pair assigned to the particular media flow to the SGSN at every PDP context activation.

At 1004, the radio access bearer setup is performed. At 1006, the SGSN sends the tuple pair to the GGSN in the Create PDP Context Request message. At 1008 and 1010, the (secondary) PDP context activation is accepted.

FIG. 11 is a signaling flow diagram illustrating coordination of the application layer and transport layer in accordance with another arrangement of the fourth embodiment of the invention. FIG. 11 presents an example of charging coordination or other kinds of information coordination for a mobile-terminated call. With reference to FIG. 11, at 1100 the MS receives the SIP INVITE message. The caller has allocated the destination tuple values for each intended original or dynamically added media component for the call. At 1102, the MS activates at least one secondary PDP context for the call. The MS sends the tuple or tuple pair to the SGSN in the Activate (Secondary) PDP Context Request message. If multiple PDP contexts are activated for the call, the MS has to send the tuple or tuple pair to the SGSN at every PDP context activation. At 1104, the radio access bearer setup is performed. At 1106, the SGSN sends the tuple pair to the GGSN in the Create PDP Context Request message. At 1108 and 1110, the (secondary) PDP context activation is accepted.

The use of the tuple pairs in the fourth embodiment simplifies the terminal inter-layer (application layer – GPRS/UMTS layer) processing and can be used effectively regardless of whether the MS is a TE + MT combination or a unified UE. This is because the connection specific UDP and TCP port information is sent automatically without need for specific MT interception/parsing process of SIP messages from TE (as in the third embodiment) or adding an extra message (charging ID received from SGSN) to TE-originated SIP messages. The port information is sent to both CSCF in SDP part of SIP INVITE or ACK message at application layer and to SGSN & GGSN in the TFT information of PDP Context Activation Request message (The tuple pair included to each PDP context's TFT needs to be forwarded to the MT's GPRS session management layer – this can e.g. be done via MT's

implementation specific bearer management or QoS application programming interface (API)).

As a variation of the fourth embodiment, in the CSCF-GGSN interface end, the tuple pairscan be used as the key identifiers to which the charging ID (and policing authorization) is assigned or linked to, although the charging ID would be used for the identifier in CGR and billing. A call is triggered over the primary (signalling) PDP context by sending a call setup (in SIP: INVITE) message with logical channel information for the receiver side (i.e., the ports to which it is ready to receive real-time data. The CSCF receives the INVITE with SDP (with coded bandwidth and port information) and stores the information. The signalling is sent to the remote end, which is answered (e.g., SIP 183 message) and the CSCF now receives a new set of SDP information with codec, bandwidth and terminating side destination ports provided by the remote end SDP. CSCF executed examination ofthe codec type data received from SIP messages from both terminals results in an agreed codec set, whose destination [IP address, port] tuple values are known for each IP connection CSCF should authorise.

The CSCF can use the CSCF-PCF-GGSN interfaces (or CSCF-GGSN if PCF is integrated to CSCF) to request policy control actions (bandwidth authorization) and charging coordination between layers with the tuplesas keys. The GGSN admits the bandwidth and later during the secondary PDP context activation process, assigns the charging ID to the created PDP context associated with the key tuple values, and forwards the charging ID back to the CSCF for charging coordination purposes. The CSCF doesn't need to parse the Charging-ID from received SIP messages - there is no risk of malicious MT since it won't be intercepting or modifying any SIP messages received from a TE. Instead it can correlate the charging ID sent by GGSN to the port information.

The charging flexibility offered for the operator is further improved in the fourth embodiment if the TE sends a RE-INVITE message with changed QoS/codec

information, since the CSCF will notice outcome of the dynamic change in the resulting signalling, and request new authorization and get a new charging ID. Furthermore, a new charging ID will be created to charging records for each new dynamically added real-time PDP context/media flow. If the real-time flows are to utilise RTP/UDP/IP header compression at the PDP layer, each media flow needs its own PDP context. Thus, operator charging can, if desired, follow the media changes (audio to videotelephony back to audio,...) within an end-to-end call. Following the process described in the third embodiment of this invention, the Call-ID would not change and would not indicate the media specific connection details in the charging information if, for example, SGSN and GGSN CDRs are omitted by an operator decision.

It is to be noted that in the description of the invention above, numerous details known to those skilled in the art have been omitted for the sake of brevity. Such details are readily available in numerous publications including the previously cited protocols.

Although the present invention has been described with reference to a number of illustrative embodiments, it should be understood that numerous other modifications and embodiments can be devised by those skilled the art which will fall within the spirit and scope of the principles of this invention. More particularly, reasonable variations and modifications are possible in the component parts and/or arrangements of the subject combination arrangement within the scope of the foregoing disclosure, the drawings, and the appended claims without departing from the spirit of the invention. In addition to variations and modifications in the component parts and/or arrangements, alternative uses will also be apparent to those skilled the art.

WHAT IS CLAIMED IS:

1. A method for coordinating charging information in a communications network, the method comprising:

establishing a communication channel;

associating a charging identification with said communication channel; and

sending said charging identification from a first network element in the transport layer to a second network element in the application layer.

2. The method of claim 1, wherein said second network element adds said charging identification to charging information which said second network element collects.

3. The method of claim 1, wherein said first network element sends an address of a network element together with said charging identification to said second network element.

4. The method of claim 3, wherein said second network element adds said address of a network element to charging information which said second network element collects.

5. The method of claim 1 or 3, wherein said first network element sends security information together with said charging identification to said second network element.

6. The method of claim 5, wherein said second network element verifies said charging identification against said security information.

7. The method of claim 1, wherein said communication channel is a Packet Data Protocol (PDP) context.

8. The method of claim 1, wherein said charging identification is a GGSN allocated Charging Id.

9. The method of claim 1, wherein said first network element is a Mobile Station (MS).

10. The method of claim 1, wherein said first network element is a Serving GPRS Support Node (SGSN).

11. The method of claim 1, wherein said first network element is a Gateway GPRS Support Node (GGSN).

12. The method of claim 1, wherein said second network element is a Call State Control Function (CSCF).

13. The method of claim 9 or 12, wherein an SGSN sends said address of a network element to said first network element.

14. The method of claim 9, 10, 11 or 12, wherein said address of a network element is an address of a GGSN.

15. The method of claim 1, wherein said transport layer is a GPRS/UMTS.

16. The method of claim 1, wherein said transport layer is a Packet Switched Core Network domain.

17. The method of claim 1, wherein said application layer is a IP Multimedia Core Network domain.

18. The method of claim 1, wherein said communication network is a packet switched wireless network.

19. The method of claim 1, wherein

sending said charging identification is performed autonomously.

20. The method of claim 1, wherein

sending said charging identification is performed based on a request from said second network element.

21. The method of claim 1, wherein said second network element sends said charging identification towards an endpoint of a communication.

22. The method of claim 21, wherein said second network element sends security information together with said charging identification toward said endpoint of a communication.

23. The method of claim 21, wherein said second network element sends an address of a network element together with said charging identification to said endpoint of a communication.

24. The method of claim 9, wherein said second network element adds an address of said first network element to charging information which said second network element collects.

25. A method for coordinating information between a transport layer and an application layer in a communications network, the method comprising:

initiating a transaction in said application layer of a first network element;

assigning an identification to said transaction;

initiating a communication channel in said transport layer of said first network element; and

associating said communication channel with said transaction using said identification.

26. The method of claim 25, wherein said identification is forwarded to a second network element in said application layer.

27. The method of claim 26, wherein said identification is forwarded to a third network element and a fourth network element in a transport layer.

28. The method of claim 27, wherein charging information generated by said fourth network element and said third network element in said transport layer and by the second network element in said application layer is associated with said identification.

29. The method of claim 25, wherein said identification is a call identification of a SIP message.

30. The method of claim 26, wherein said second network element is a CSCF.

31. The method of claim 27, wherein said third network element is a SGSN and said fourth network element is a GGSN.

32. The method of claim 28, wherein said charging information is a CDR.

33. The method of claim 25, wherein said communication channel is a Packet Data Protocol (PDP) context.

34. The method of claim 25, wherein said transaction is a call.

35. A system for coordinating information between an application layer and a transport layer in a communication network, the system comprising:

means for initiating a transaction in said application layer of a first network element;

means for assigning an identification to said transaction;

means for initiating a communication channel in said transport layer of said first network element; and

means for associating said communication channel with said transaction using said identification.

36. A method for coordinating charging information in a communications network, the method comprising:

establishing a communication connection;

generating a globally unique charging identification in a first network element and associating said globally unique charging identification with said communication connection; and

sending said globally unique charging identification from said first network element to a second network element.

37. The method of claim 36, wherein said second network element uses said globally unique charging identification to collect charging information.

38. The method of claim 36, wherein said globally unique charging identification includes the address of the first network element.

39. The method of claim 36, wherein said communication channel is a Packet Data Protocol (PDP) context.

40. The method of claim 36, wherein said globally unique charging identification is generated by a GGSN.

41. The method of claim 36, wherein said first network element is a Mobile Station (MS).

42. The method of claim 36, wherein said first network element is a Serving GPRS Support Node (SGSN).

43. The method of claim 36, wherein said first network element is a Gateway GPRS Support Node (GGSN).

44. The method of claim 36, wherein said second network element is a Call State Control Function (CSCF).

45. The method of claim 36, wherein said second network element sends said globally unique charging identification towards an endpoint of a communication.

46. The method of claim 45, wherein said second network element sends said globally unique charging identification to a second network.

47. The method of claim 45, wherein said second network collects charging data using said globally unique charging identification and prepares billing using the collected charging data.

48. The method of claim 47, wherein said second network collects charging data from a plurality of call detail records associated with said globally unique charging identification.

49. A method for coordinating information between a transport layer and an application layer in a communications network, the method comprising:

initiating a transaction in said application layer of a first network element;

assigning a tuple or tuple pair for each communication connection within said transaction;

initiating at least one communication connection in said transport layer of said first network element; and

associating said at least one communication connection with said transaction using said tuple or tuple pair.

50. The method of claim 49, wherein said tuple or tuple pair is forwarded to a second network element in said application layer.

51. The method of claim 50, wherein said tuple or tuple pair is forwarded to a third network element and a fourth network element in a transport layer.

52. The method of claim 51, wherein charging information generated by said fourth network element and said third network element in said transport layer and by the second network element in said application layer is associated with said tuple or tuple pair.

53. The method of claim 49, wherein said tuple includes a destination IP address and port information of a transaction specific media connection.

54. The method of claim 50, wherein said second network element is a CSCF.

55. The method of claim 51, wherein said third network element is a SGSN and said fourth network element is a GGSN.

56. The method of claim 52, wherein said charging information is a CDR.

57. The method of claim 49, wherein said communication connection is a Packet Data Protocol (PDP) context.

58. The method of claim 49, wherein said transaction is a call.

59. A system for coordinating information between an application layer and a transport layer in a communications network, the system comprising:

means for initiating a transaction in said application layer of a first network element;

means for assigning a tuple or tuple pair to said transaction;

means for initiating at least one communication connection in said transport layer of said first network element; and

means for associating said at least one communication connection with said transaction using said tuple or tuple pair.

FIG. 1

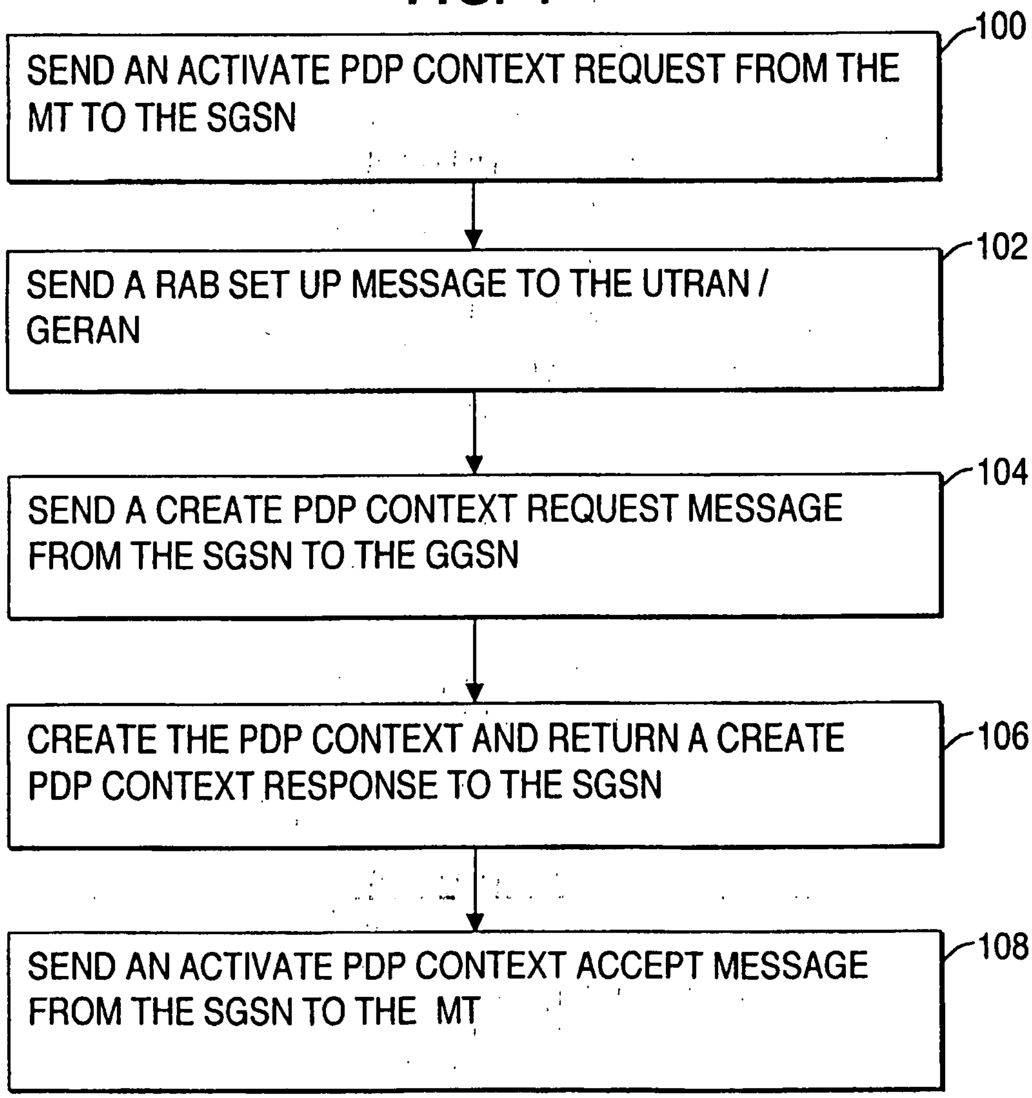

SEND AN ACTIVATE PDP CONTEXT REQUEST FROM THE MT TO THE SGSN
100
SEND A RAB SET UP MESSAGE TO THE UTRAN / GERAN
102
SEND A CREATE PDP CONTEXT REQUEST MESSAGE FROM THE SGSN TO THE GGSN
104
CREATE THE PDP CONTEXT AND RETURN A CREATE PDP CONTEXT RESPONSE TO THE SGSN
106
SEND AN ACTIVATE PDP CONTEXT ACCEPT MESSAGE FROM THE SGSN TO THE MT
108

FIG. 2

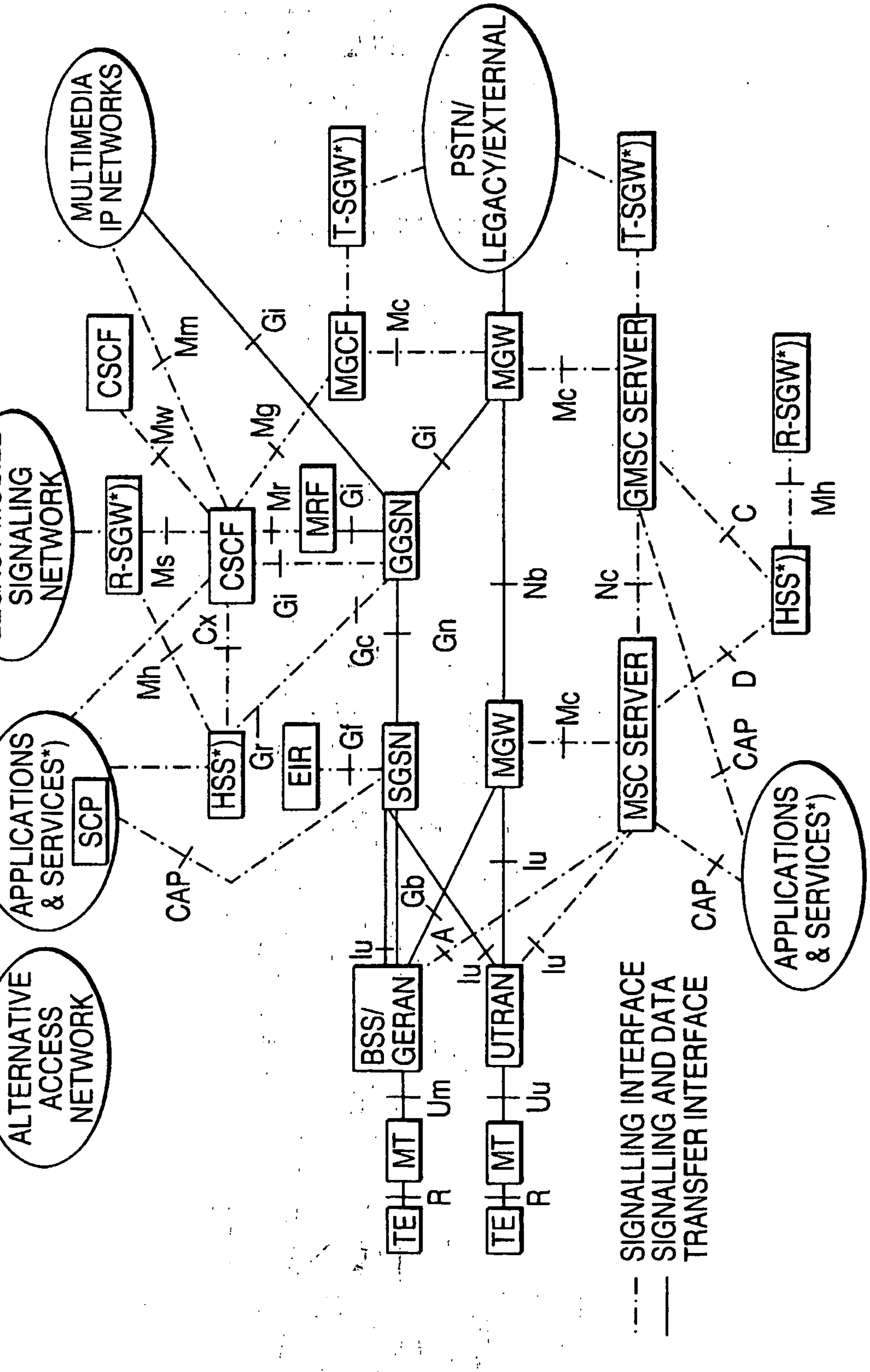

ALTERNATIVE ACCESS NETWORK
APPLICATIONS & SERVICES*)
SCP
LEGACY MOBILE SIGNALING NETWORK
R-SGW*)
CSCF
MULTIMEDIA IP NETWORKS
Mm
Mw
Ms
Mh
Cx
Mr
Mg
Gi
MRF
MGCF
Mc
T-SGW*)
PSTN/ LEGACY/EXTERNAL
HSS*)
Gr
EIR
Gf
SGSN
Gc
Gn
GGSN
MGW
Nb
CAP
Gb
Iu
A
BSS/ GERAN
UTRAN
Um
Uu
MT
TE
R
MSC SERVER
Nc
GMSC SERVER
C
D
Mh
R-SGW*)
HSS*)
CAP
APPLICATIONS & SERVICES*)
SIGNALLING INTERFACE
SIGNALLING AND DATA TRANSFER INTERFACE

FIG. 3

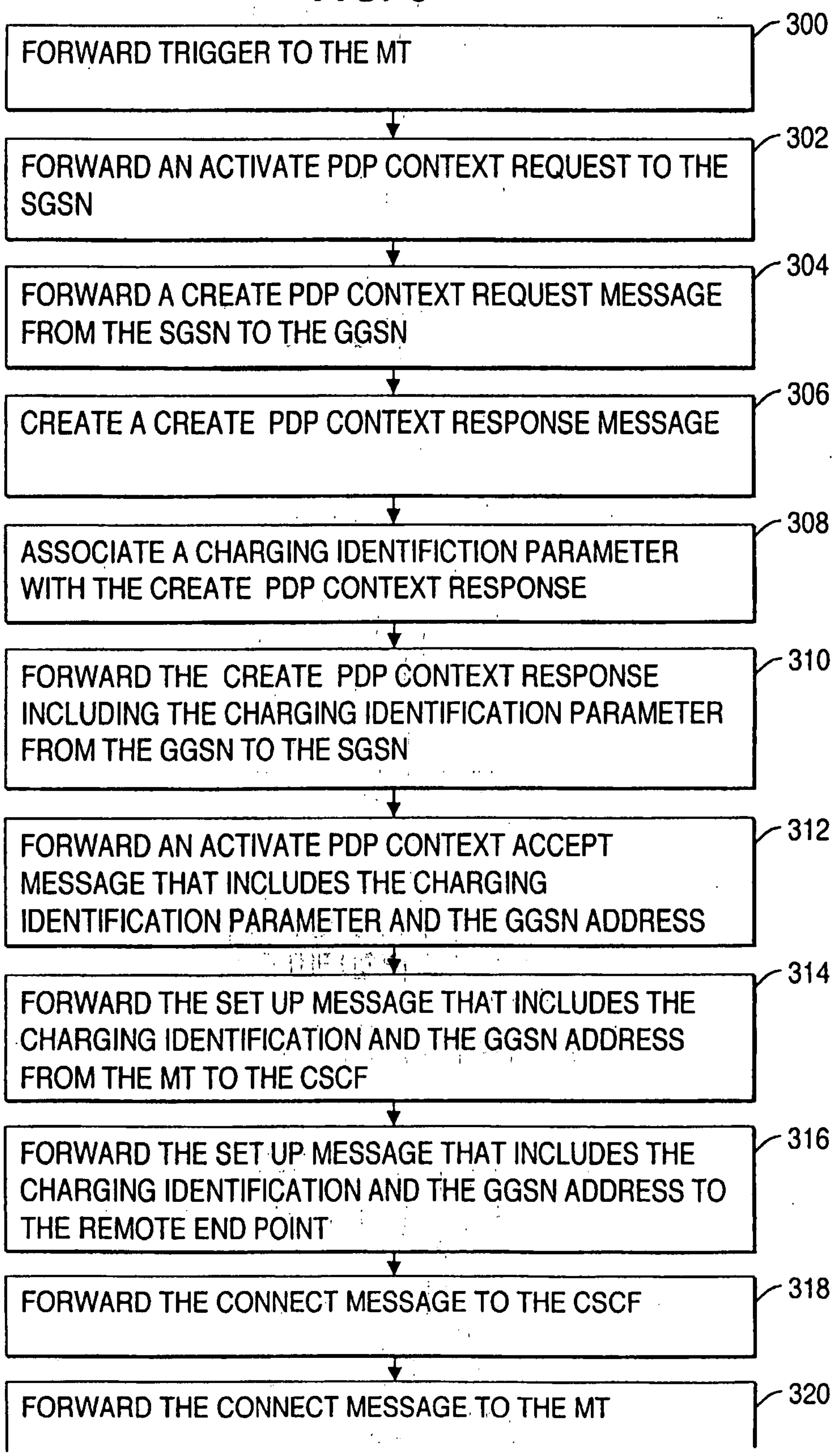

FORWARD TRIGGER TO THE MT
300
FORWARD AN ACTIVATE PDP CONTEXT REQUEST TO THE SGSN
302
FORWARD A CREATE PDP CONTEXT REQUEST MESSAGE FROM THE SGSN TO THE GGSN
304
CREATE A CREATE PDP CONTEXT RESPONSE MESSAGE
306
ASSOCIATE A CHARGING IDENTIFICTION PARAMETER WITH THE CREATE PDP CONTEXT RESPONSE
308
FORWARD THE CREATE PDP CONTEXT RESPONSE INCLUDING THE CHARGING IDENTIFICATION PARAMETER FROM THE GGSN TO THE SGSN
310
FORWARD AN ACTIVATE PDP CONTEXT ACCEPT MESSAGE THAT INCLUDES THE CHARGING IDENTIFICATION PARAMETER AND THE GGSN ADDRESS
312
FORWARD THE SET UP MESSAGE THAT INCLUDES THE CHARGING IDENTIFICATION AND THE GGSN ADDRESS FROM THE MT TO THE CSCF
314
FORWARD THE SET UP MESSAGE THAT INCLUDES THE CHARGING IDENTIFICATION AND THE GGSN ADDRESS TO THE REMOTE END POINT
316
FORWARD THE CONNECT MESSAGE TO THE CSCF
318
FORWARD THE CONNECT MESSAGE TO THE MT
320

FIG. 4

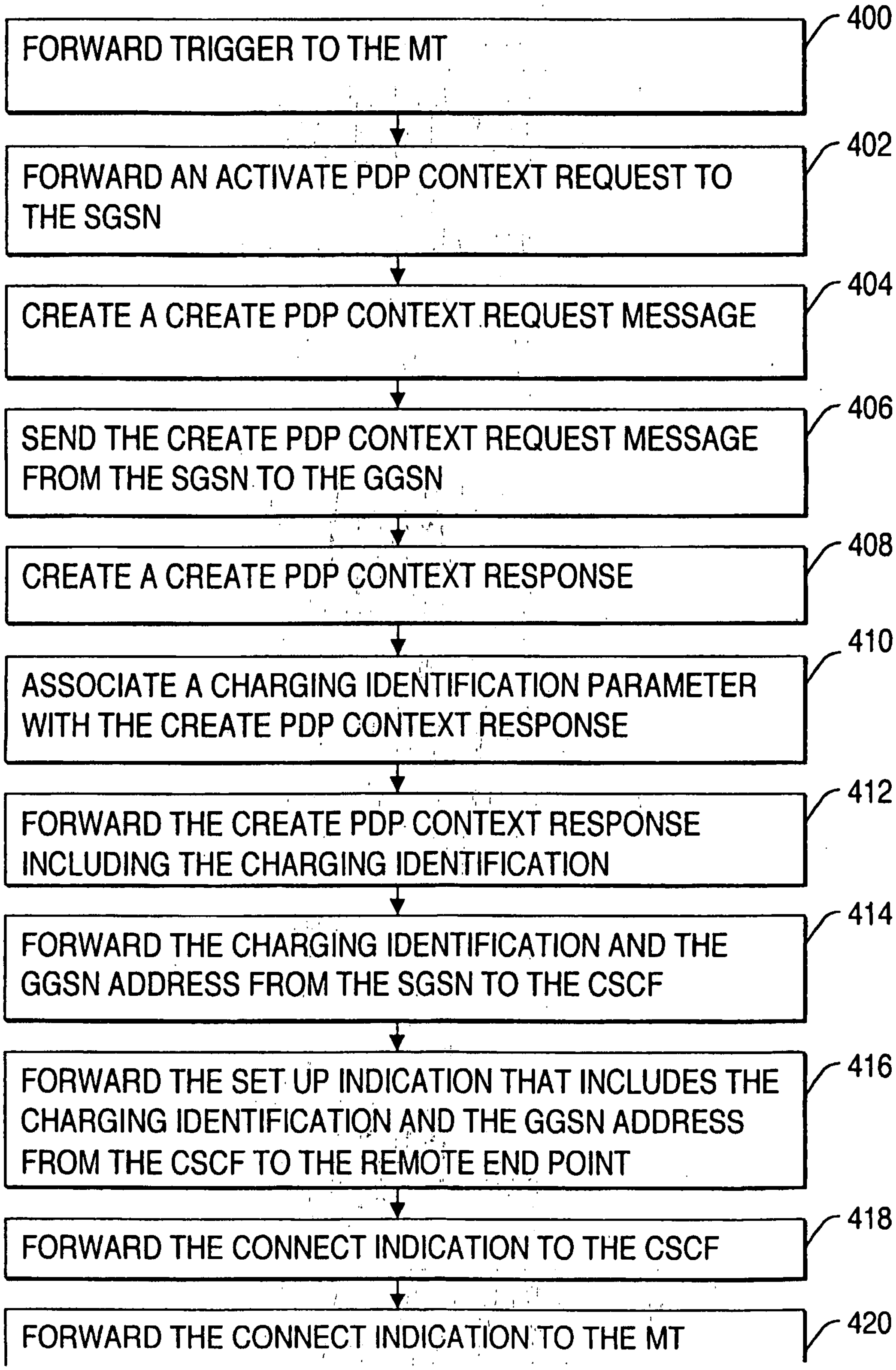

FORWARD TRIGGER TO THE MT
400
FORWARD AN ACTIVATE PDP CONTEXT REQUEST TO THE SGSN
402
CREATE A CREATE PDP CONTEXT REQUEST MESSAGE
404
SEND THE CREATE PDP CONTEXT REQUEST MESSAGE FROM THE SGSN TO THE GGSN
406
CREATE A CREATE PDP CONTEXT RESPONSE
408
ASSOCIATE A CHARGING IDENTIFICATION PARAMETER WITH THE CREATE PDP CONTEXT RESPONSE
410
FORWARD THE CREATE PDP CONTEXT RESPONSE INCLUDING THE CHARGING IDENTIFICATION
412
FORWARD THE CHARGING IDENTIFICATION AND THE GGSN ADDRESS FROM THE SGSN TO THE CSCF
414
FORWARD THE SET UP INDICATION THAT INCLUDES THE CHARGING IDENTIFICATION AND THE GGSN ADDRESS FROM THE CSCF TO THE REMOTE END POINT
416
FORWARD THE CONNECT INDICATION TO THE CSCF
418
FORWARD THE CONNECT INDICATION TO THE MT
420

FIG. 5

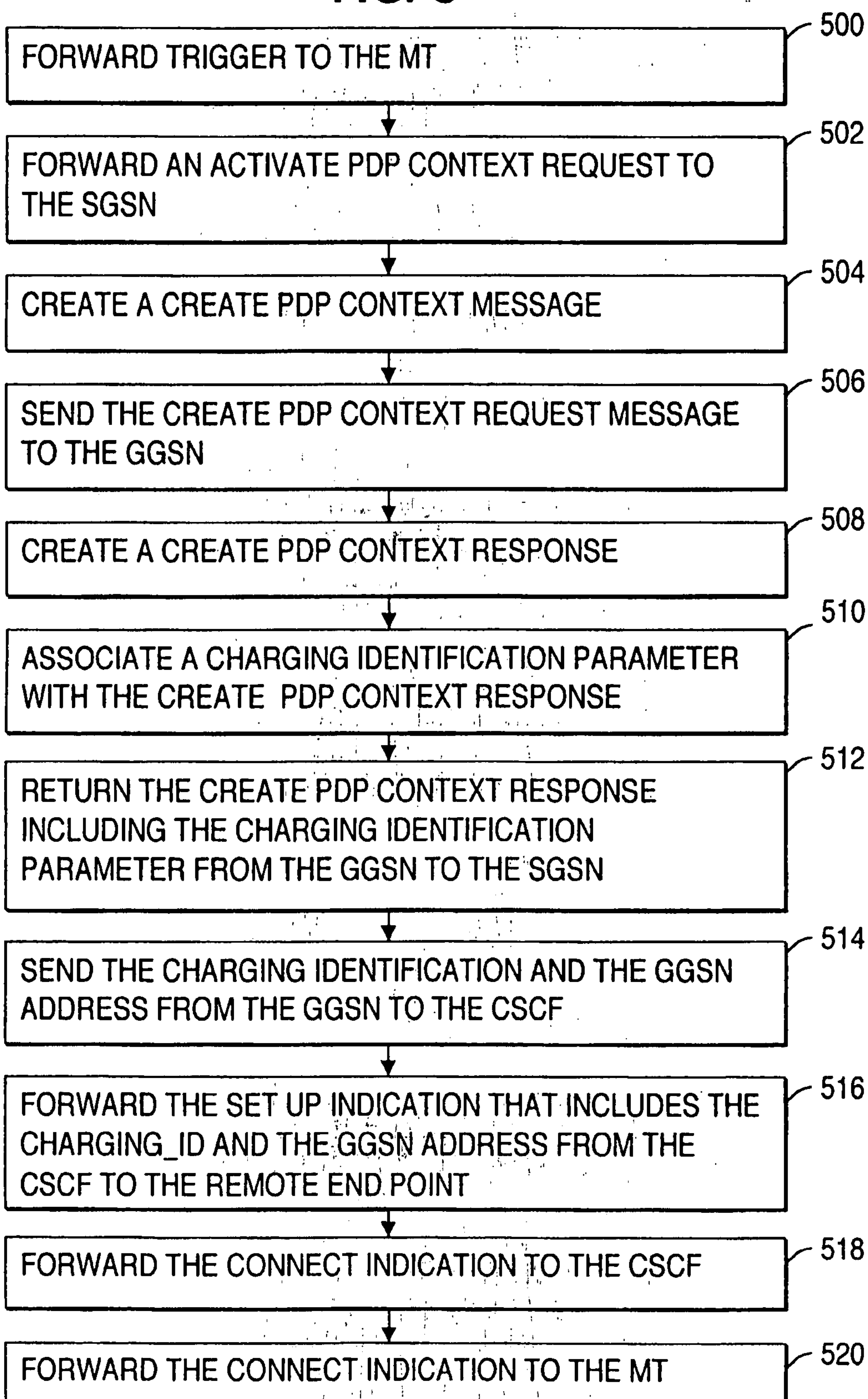

FORWARD TRIGGER TO THE MT
500
FORWARD AN ACTIVATE PDP CONTEXT REQUEST TO THE SGSN
502
CREATE A CREATE PDP CONTEXT MESSAGE
504
SEND THE CREATE PDP CONTEXT REQUEST MESSAGE TO THE GGSN
506
CREATE A CREATE PDP CONTEXT RESPONSE
508
ASSOCIATE A CHARGING IDENTIFICATION PARAMETER WITH THE CREATE PDP CONTEXT RESPONSE
510
RETURN THE CREATE PDP CONTEXT RESPONSE INCLUDING THE CHARGING IDENTIFICATION PARAMETER FROM THE GGSN TO THE SGSN
512
SEND THE CHARGING IDENTIFICATION AND THE GGSN ADDRESS FROM THE GGSN TO THE CSCF
514
FORWARD THE SET UP INDICATION THAT INCLUDES THE CHARGING_ID AND THE GGSN ADDRESS FROM THE CSCF TO THE REMOTE END POINT
516
FORWARD THE CONNECT INDICATION TO THE CSCF
518
FORWARD THE CONNECT INDICATION TO THE MT
520

FIG. 6

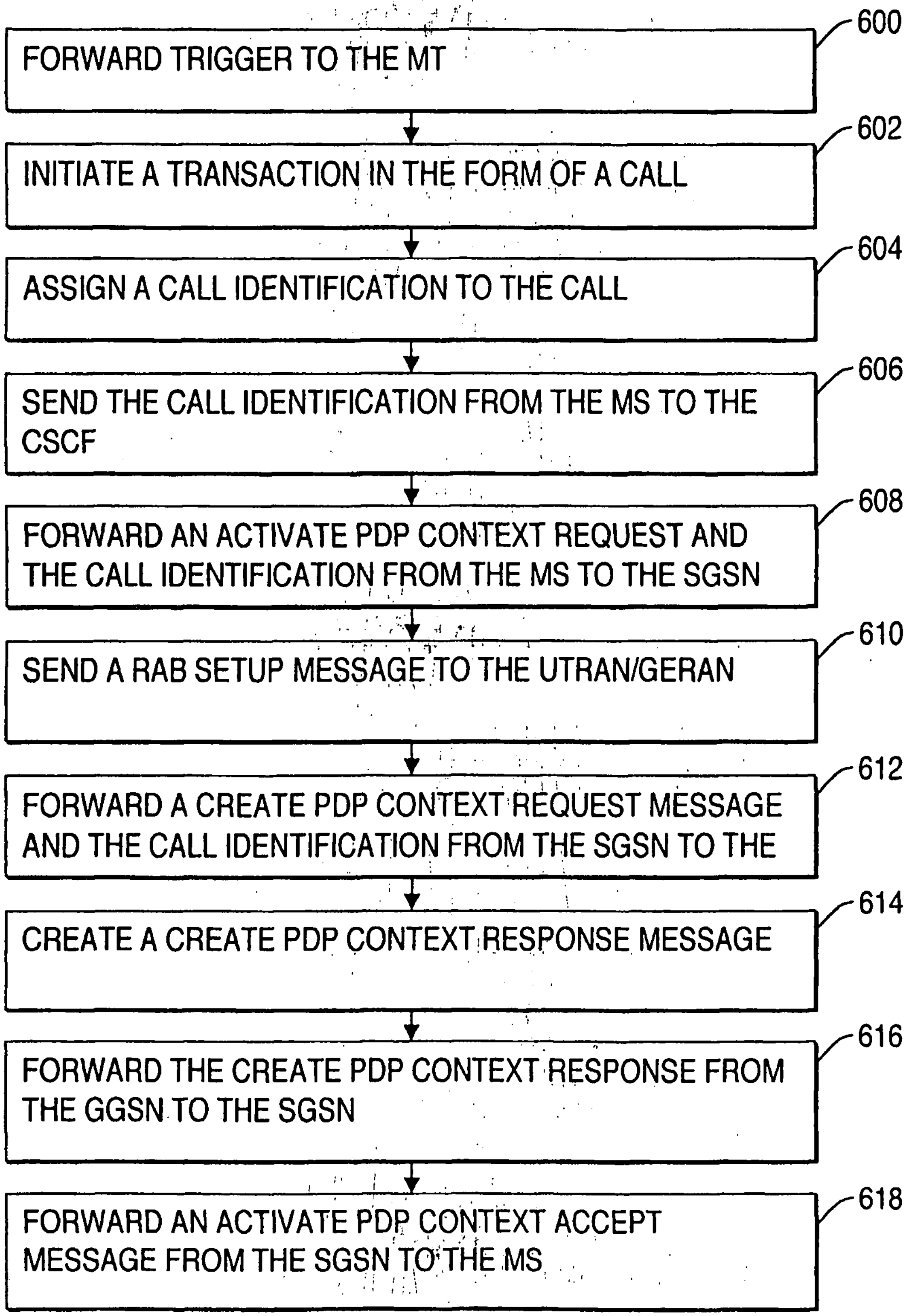

FORWARD TRIGGER TO THE MT
600
INITIATE A TRANSACTION IN THE FORM OF A CALL
602
ASSIGN A CALL IDENTIFICATION TO THE CALL
604
SEND THE CALL IDENTIFICATION FROM THE MS TO THE CSCF
606
FORWARD AN ACTIVATE PDP CONTEXT REQUEST AND THE CALL IDENTIFICATION FROM THE MS TO THE SGSN
608
SEND A RAB SETUP MESSAGE TO THE UTRAN/GERAN
610
FORWARD A CREATE PDP CONTEXT REQUEST MESSAGE AND THE CALL IDENTIFICATION FROM THE SGSN TO THE
612
CREATE A CREATE PDP CONTEXT RESPONSE MESSAGE
614
FORWARD THE CREATE PDP CONTEXT RESPONSE FROM THE GGSN TO THE SGSN
616
FORWARD AN ACTIVATE PDP CONTEXT ACCEPT MESSAGE FROM THE SGSN TO THE MS
618

FIG. 7

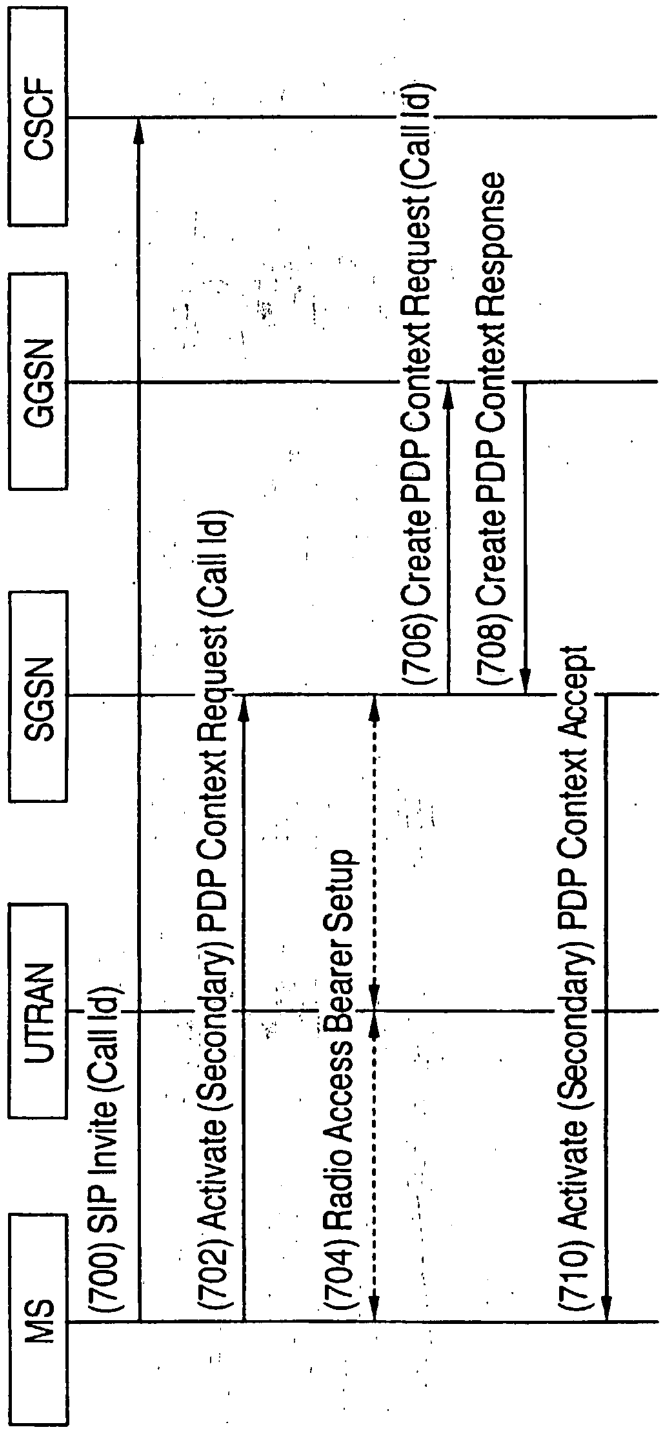

MS
UTRAN
SGSN
GGSN
CSCF
(700) SIP Invite (Call Id)
(702) Activate (Secondary) PDP Context Request (Call Id)
(704) Radio Access Bearer Setup
(706) Create PDP Context Request (Call Id)
(708) Create PDP Context Response
(710) Activate (Secondary) PDP Context Accept

FIG. 8

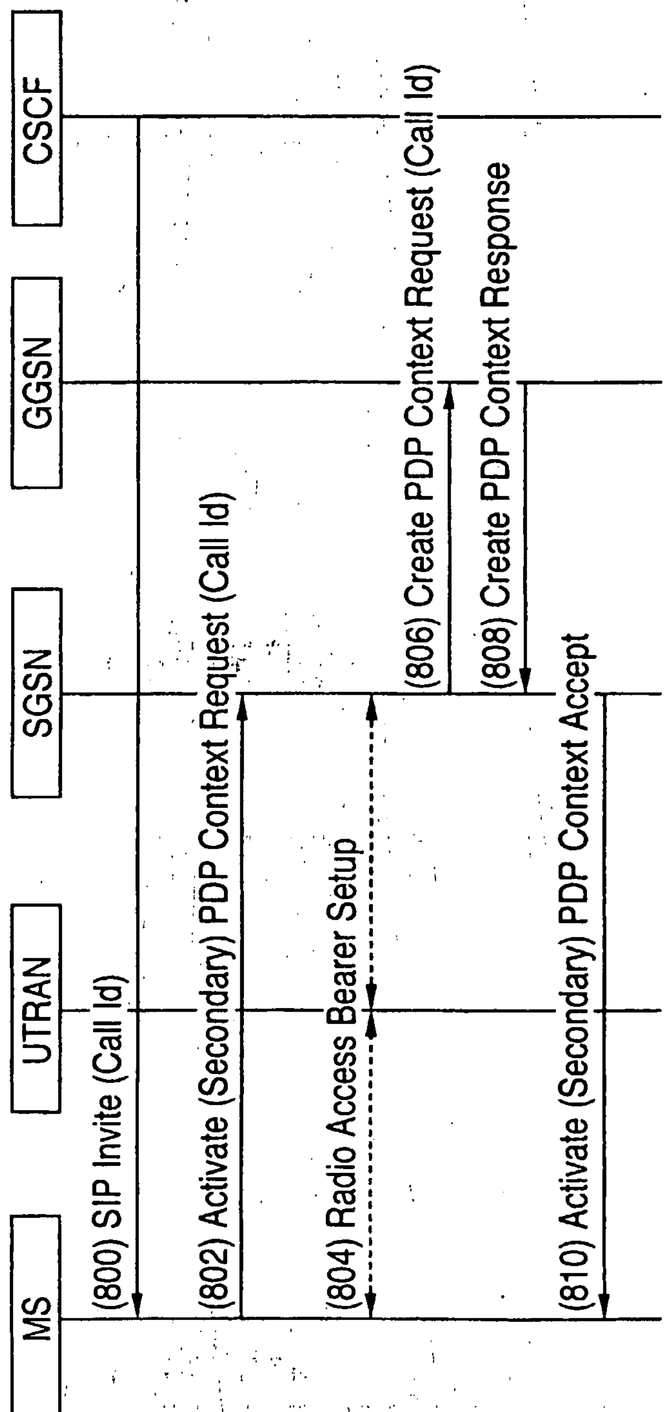

MS
UTRAN
SGSN
GGSN
CSCF
(800) SIP Invite (Call Id)
(802) Activate (Secondary) PDP Context Request (Call Id)
(804) Radio Access Bearer Setup
(806) Create PDP Context Request (Call Id)
(808) Create PDP Context Response
(810) Activate (Secondary) PDP Context Accept

FIG. 9

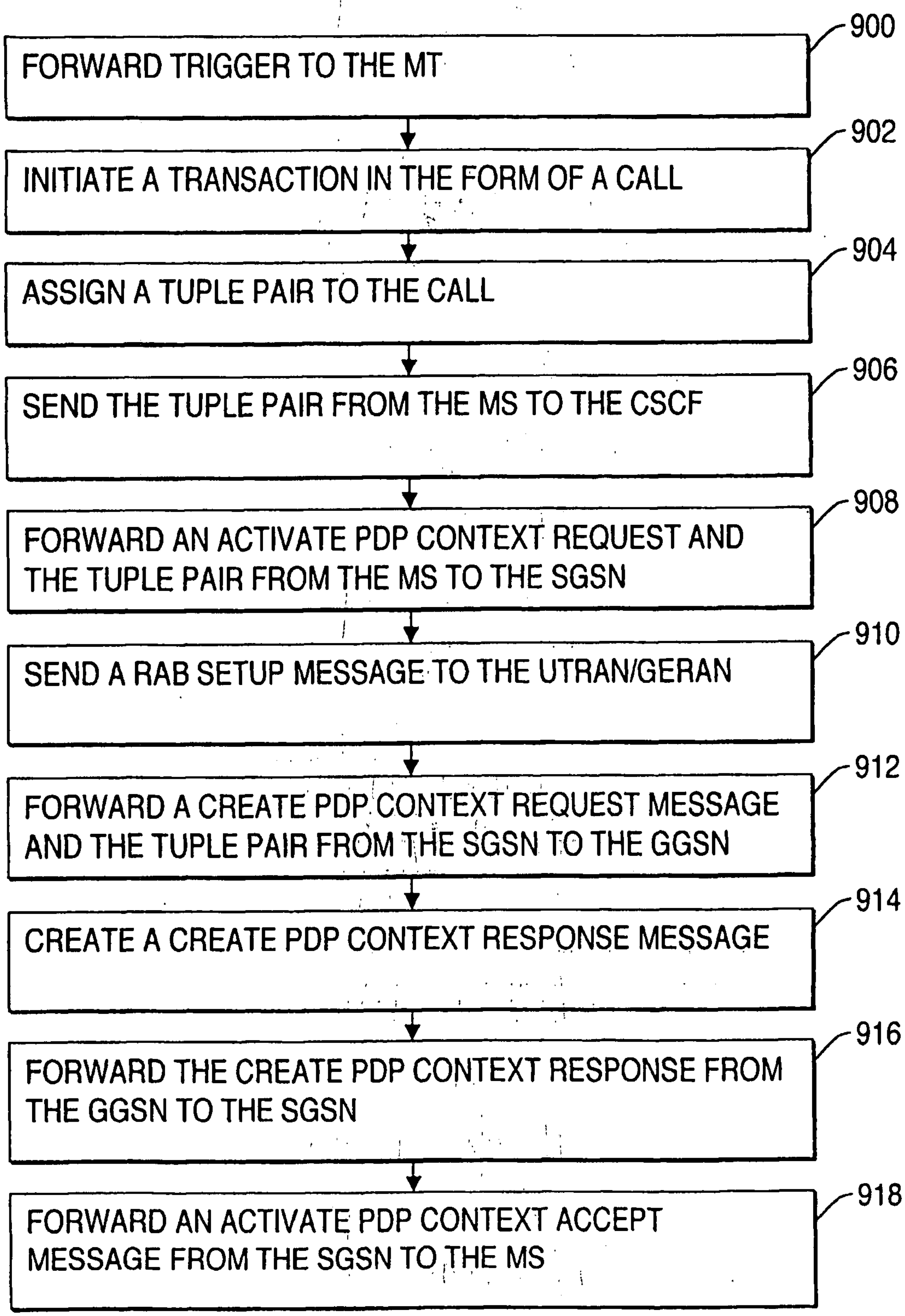

900
FORWARD TRIGGER TO THE MT
902
INITIATE A TRANSACTION IN THE FORM OF A CALL
904
ASSIGN A TUPLE PAIR TO THE CALL
906
SEND THE TUPLE PAIR FROM THE MS TO THE CSCF
908
FORWARD AN ACTIVATE PDP CONTEXT REQUEST AND THE TUPLE PAIR FROM THE MS TO THE SGSN
910
SEND A RAB SETUP MESSAGE TO THE UTRAN/GERAN
912
FORWARD A CREATE PDP CONTEXT REQUEST MESSAGE AND THE TUPLE PAIR FROM THE SGSN TO THE GGSN
914
CREATE A CREATE PDP CONTEXT RESPONSE MESSAGE
916
FORWARD THE CREATE PDP CONTEXT RESPONSE FROM THE GGSN TO THE SGSN
918
FORWARD AN ACTIVATE PDP CONTEXT ACCEPT MESSAGE FROM THE SGSN TO THE MS

FIG. 10

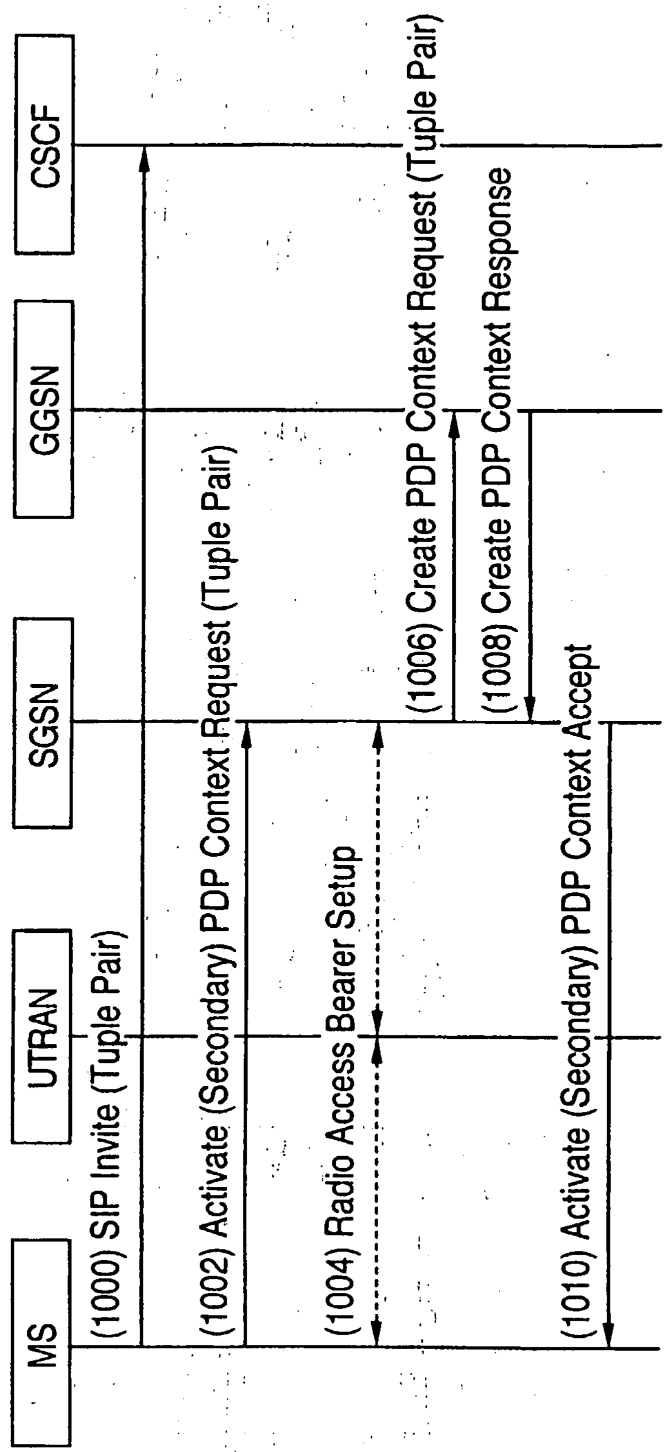
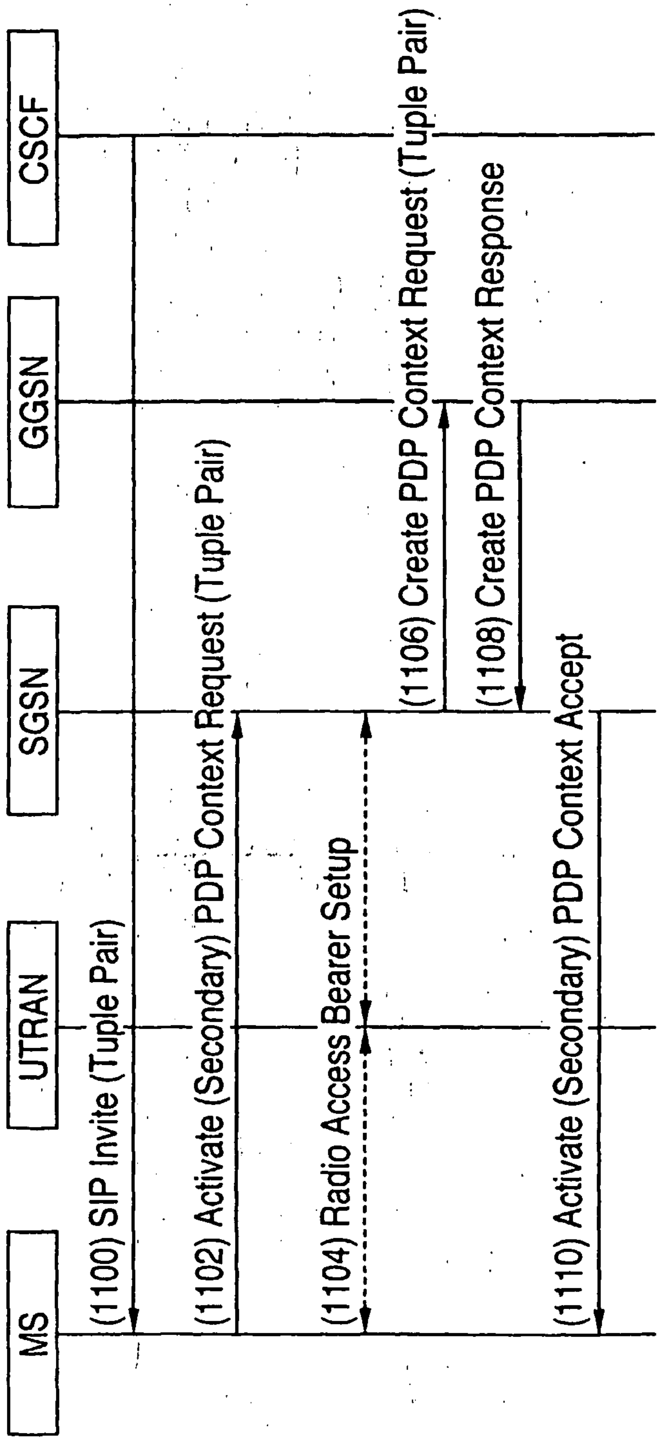

MS
UTRAN
SGSN
GGSN
CSCF
(1000) SIP Invite (Tuple Pair)
(1002) Activate (Secondary) PDP Context Request (Tuple Pair)
(1004) Radio Access Bearer Setup
(1006) Create PDP Context Request (Tuple Pair)
(1008) Create PDP Context Response
(1010) Activate (Secondary) PDP Context Accept

FIG. 11


MS
UTRAN
SGSN
GGSN
CSCF
(1100) SIP Invite (Tuple Pair)
(1102) Activate (Secondary) PDP Context Request (Tuple Pair)
(1104) Radio Access Bearer Setup
(1106) Create PDP Context Request (Tuple Pair)
(1108) Create PDP Context Response
(1110) Activate (Secondary) PDP Context Accept

3GPP TS 23.125 V6.0.0 (2004-03)

Technical Specification

3rd Generation Partnership Project;
Technical Specification Group Services and System Aspects;
Overall High Level Functionality and Architecture Impacts of Flow Based Charging;
Stage 2
(Release 6)

Keywords

UMTS, charging, stage 2, architecture

3GPP

Postal address

3GPP support office address

650 Route des Lucioles - Sophia Antipolis
Valbonne - FRANCE
Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16

Internet

http://www.3gpp.org

Contents

Foreword

This Technical Specification has been produced by the 3rd Generation Partnership Project (3GPP).

The contents of the present document are subject to continuing work within the TSG and may change following formal TSG approval. Should the TSG modify the contents of the present document, it will be re-released by the TSG with an identifying change of release date and an increase in version number as follows:

Version x.y.z

where:

x the first digit:

1 presented to TSG for information;

2 presented to TSG for approval;

3 or greater indicates TSG approved document under change control.

y the second digit is incremented for all changes of substance, i.e. technical enhancements, corrections, updates, etc.

z the third digit is incremented when editorial only changes have been incorporated in the document.

1 Scope

The present document specifies the overall high level functionality and architecture impacts of Flow Based Charging.

2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document.*

[1] 3GPP TR 41.001: "GSM Release specifications".

[2] 3GPP TS 21.905: "Vocabulary for 3GPP Specifications".

[3] 3GPP TS 32.200: "Charging Principles".

[4] 3GPP TS 23.228: "IP Multimedia (IM) Subsystem - Stage 2".

[5] 3GPP TS 23.002: "Network architecture".

[6] 3GPP TS 23.060: "General Packet Radio Service (GPRS); Service description; Stage 2".

[7] 3GPP TS 32.225: "Telecommunication management; Charging management; Charging data description for the IP Multimedia Subsystem (IMS)".

[8] 3GPP TS 23.078: "Customised Applications for Mobile network Enhanced Logic (CAMEL); Stage 2".

3 Definitions, symbols and abbreviations

3.1 Definitions

For the purposes of the present document, the terms and definitions given in TS 21.905 [2] and in TS 32.225 [7] and the following apply:

Charging key: information used by the online and offline charging system for rating purposes.

Charging rule: a set of information comprising the service data flow filters, charging key, and the associated charging actions, for a single service data flow (further details can be found in 4.3).

Dynamic charging rule: Charging rule where some of the data within the charging rule (e.g. service data flow filter information) is assigned via real-time analysis, which may use dynamic application derived criteria.

Packet flow: a specific user data flow carried through the Traffic Plane Function. A packet flow can be an IP flow.

Predefined charging rule: Static charging rule which is defined in the Traffic Plane Function.

Service data flow: aggregate set of packet flows. In the case of GPRS, it shall be possible that a service data flow is more granular than a PDP context.

Service Data Flow Filter: a set of filter parameters used to identify one or more of the packet flows constituting a service data flow. At least the following means for the packet flow identification shall be supported: source and destination IP address+port, transport protocol, or application protocol.

Static charging rule: Charging rule where all of the data within the charging rule describing the service data flow is permanently configured throughout the duration of a user's data session. A static charging rule may be activated dynamically.

3.2 Symbols

For the purposes of the present document, the following symbols apply:

3.3 Abbreviations

For the purposes of the present document, the following abbreviations apply:

AF	Application Function
CCF	Charging Collection Function
CDR	Charging Data Records
CRF	Charging Rules Function
CSCF	Call Session Control Function
FBC	Flow Based Charging
FTP	File Transfer Protocol
G-CDR	GGSN generated CDR
GGSN	Gateway GPRS Support Node
GPRS	General Packet Radio Service
gsmSCF	GSM Service Control Function
HPLMN	Home PLMN
HTTP	Hypertext Transfer Protocol
I-CSCF	Interrogating CSCF
IM	IP Multimedia
IMS	IP Multimedia Core Network Subsystem
IMSI	International Mobile Subscriber Identity
OCS	Online Charging System
P-CSCF	Proxy-CSCF
PDG	Packet Data Gateway
PLMN	Public Land Mobile Network
QoS	Quality of Service
SAI	Service Area Identity
S-CDR	SGSN generated CDR
S-CSCF	Serving-CSCF
SBLP	Service Based Local Policy
SDF	Service Data Flow
SGSN	Serving GPRS Support Node
SIP	Session Initiation Protocol
TPF	Traffic Plane Function
UE	User Equipment
WAP	Wireless Application Protocol
WLAN	Wireless LAN

4 General Requirements

4.1 General

The current level of traffic differentiation and traffic-type awareness of the GPRS architecture shall be extended beyond APN and PDP Context level. It shall be possible to apply differentiated charging for the traffic flows belonging to different services (a.k.a. different service data flows) even if they use the same PDP Context.

In addition, it shall be possible to apply differentiated charging for the traffic flows belonging to different services carried by other IP Connectivity Access Networks (IP-CANs).

Charging and tariffing models described in this Technical Specification shall be possible to be applied to both prepaid and postpaid subscribers, i.e. to both online and offline charging.

Online and offline are not the same as prepaid and postpaid (see TS 32.225 [7]). For example it is worth highlighting that the operator can have postpaid subscribers on credit control by using on-line charging mechanisms.

The GPRS online charging solutions up to release 5 are built around CAMEL mechanisms that provide online access- and charging-control for GPRS - pertaining to PDP Contexts of an APN.

The flow based charging architecture developed in this Technical Specification shall use generic native IP charging mechanisms to the extent possible in order to enable the reuse of the same charging solution and infrastructure for different type of IP-Connectivity Networks.

Note: Providing differentiated service data flow based charging is a different function from providing differentiated traffic treatment on the IP-flow level. The operation of service data flow based charging shall not mandate the operation of service based local policy.

In addition charging based on specific application services or protocols shall be supported.

4.2 Backwards compatibility

The capabilities of the enhanced architecture introduced with flow based charging shall be backwards compatible with the release 5 charging capabilities. These new functions shall be compatible and coherent with the authentication, authorization, PDP context management, roaming and other functions provided by the release 5 architecture.

It shall be possible to collect data volumes per PDP context for use in billing and operational management systems.

It shall be possible to derive data volumes, which are not subject to service data flow based charging. The data volumes may be charged according to the GPRS mechanisms.

4.3 Charging models

4.3.1 General

When developing the charging solutions, the following charging models should be considered, even though the full solution to support the models may not be within the scope of this TS.

Shared revenue services shall be supported. In this case settlement for all parties shall be supported, including the third parties that may have been involved providing the services.

The charging solution shall allow various charging models such as:

- Volume based charging;
- Time based charging.

Editor's note: Additional charging models that are event and service based require further investigation.

It shall be possible to apply different rates when a user is identified to be roaming from when the user is in the home network.

It shall be possible to restrict special rates to a specific service, e.g. allow the user to download a certain volume of data from one service for free, but this allowed volume is not transferable to other services. It shall be possible also to apply special rates based on the time of day.

It shall be possible to enforce per-service usage limits for a service data flow using online charging on a per user basis (may apply to pre-paid and postpaid users).

In the case of online charging, and where information is available to enable service data flow packets to be associated with a specific PDP context, it shall be possible to perform rating and allocate credit depending on the characteristics of the resources allocated initially (in the GPRS case, the QoS of the PDP context).

The flow based bearer level charging can support dynamic selection of charging to apply. A number of different inputs can be used in the decision to identify the specific charging to apply. For example, a service data flow may be charged with different rates depending on what QoS is applicable. The charging rate may thus be modified when a bearer is created or removed, to change the QoS provided for a service data flow.

The charging rate or charging model applicable to a service data flow may also be changed as a result of events in the service (e.g. insertion of a paid advertisement within a user requested media stream). The charging model applicable to a service data flow may also change as a result of events identified by the OCS (e.g. after having spent a certain amount, the user gets to use some services for free).

In the case of online charging, it shall be possible to apply an online charging action upon TPF events (e.g. re-authorization upon QoS change).

4.3.2 Examples of Service Data Flow Charging

There are many different services that may be used within a network, including both user-user and user-network services. Service data flows from these services may be identified and charged in many different ways. A number of examples of configuring charging rules for different service data flows are described below.

A network server provides an FTP service. The FTP server supports both the active (separate ports for control and data) and passive modes of operation. A charging rule is configured for the service data flows associated with the FTP server for the user. The charging rule uses a filter specification for the uplink that identifies packets sent to port 20 or 21 of the IP address of the server, and the origination information is wildcarded. In the downlink direction, the filter specification identifies packets sent from port 20 or 21 of the IP address of the server.

A network server provides a "web" service. A charging rule is configured for the service data flows associated with the HTTP server for the user. The charging rule uses a filter specification for the uplink that identifies packets sent to port 80 of the IP address of the server, and the origination information is wildcarded. In the downlink direction, the filter specification identifies packets sent from port 80 of the IP address of the server.

The same server also provides a WAP service. The server has multiple IP addresses, and the IP address of the WAP server is different from the IP address of the web server. The charging rule uses the same filter specification as for the web server, except the IP address is different.

An operator offers a zero rating for network provided DNS service. A charging rule is established setting all DNS traffic to/from the operators DNS servers as offline charged. The data flow filter identifies the DNS port number, and the source/destination address within the subnet range allocated to the operators network nodes.

An operator has a specific charging rate for user-user VoIP traffic over the IMS. A charging rule is established for this service data flow. The filter information to identify the specific service data flow for the user-user traffic is provided by the P-CSCF.

5 Flow Based Charging Concepts

5.1 Overview

Editor's note: This clause is planned to contain the relevant descriptions of the overall function for the flow based charging.

The following functions are provided by the network for service data flow based charging. This applies to both online and offline charging unless otherwise specified:

- Identification of the service data flows that need to be charged individually (e.g. at different rates);
- Provision and control of charging rules on service data flow level;
- Reporting of service data flow level byte counts;
- Event indication according to on-line charging procedures (e.g. sending AAA Accounting Stop) and, optionally, following this particular event, taking appropriate actions on service data flow(s) according to the termination action.
- Event indication and event monitoring by the TPF and following this particular event, taking the appropriate on-line charging actions.

5.2 Charging rules

Charging rules contain information that allow for filtering of traffic to identify the packets belonging to a particular service data flow, and allow for defining how the service data flow is to be charged. The following apply to charging rules:

- The charging rules for bearer charging are defined by the operator.
- These charging rules are made available to the Traffic Plane function for both offline and online charging.
- Multiple charging rules are supported simultaneously per user.
- Filtering information within a charging rule is applied through filtering functionality at the Traffic Plane Function to identify the packets belonging to a particular service data flow.
- Charging rules with dynamically provisioned filtering information (i.e. made available to the Traffic Plane Function) are supported in order to cover IP service scenarios where the filtering information is dynamically negotiated (e.g. negotiated on the application level (e.g. IMS)).
- Pre-defined charging rules are supported.
- Elements of charging rules may be statically configured at the Traffic Plane Function, or dynamically provisioned.

Note-i: The mechanism to support use of elements statically pre-defined in the TPF (e.g. filter information) is for stage 3 development.

Note-ii: The stage 3 development may also evaluate providing an optimisation to support dynamic provisioning of an entire charging rule pre-defined in the TPF.

- Pre-defined filters may support extended capabilities, including enhanced capabilities to identify packets associated with application protocols.
- There may be overlap between the charging rules that are applicable. Overlap can occur between:
    - multiple pre-defined charging rules in the TPF;

- charging rules pre-defined in the TPF and rules from the Service Data Flow Based Charging Rules Function, which can overlay the pre-defined rules in the TPF.

  The precedence identified with each charging rule shall resolve all overlap between the charging rules. When overlap occurs between a dynamically allocated charging rule and a pre-defined charging rule at the TPF, and they both share the same precedence, then the dynamically allocated charging rule shall be used.

- Charging rules contain information on:
  - How a particular service data flow is to be charged: online/offline;
  - In case of offline charging whether to record volume- or time-based charging information;
  - Charging key;
  - Service data flow filter(s);
  - Precedence.
- Once the charging rule is determined it is applied to the service data flow at the Traffic Plane Function and packets are counted and categorised per the rule set in the charging rule.
- Separate charging rules can be provided for downlink and uplink.
- Charging rules can be configured for both user initiated and network initiated flows.
- Charging rules can change and be overridden, e.g. for a previously established PDP context in the GPRS case, based on specific events (e.g. IM domain events or GPRS domain events, credit control events).
- Different charging rules can be applied for different users or groups of users.
- Different charging rules can be applied based on the location of the user (e.g. based on identity of the roamed to network).
- For GPRS, charging rule assignment can occur at PDP context establishment and modification.
- For GPRS, the charging rules can be dependent on the APN used.

5.3 Service data flow filters and counting

This section refers to the filtering that identifies the service data flows that need to be charged individually (e.g. at different rates). Basic example: look for packets of one service, e.g. to and from a server A.

- Separate filtering and counting can be applied for downlink and uplink.
- Different granularity for service data flow filters identifying the service data flow is possible e.g.
  - Filters based on the IP 5 tuple (source IP address, destination IP address, source port number, destination port number, protocol ID of the protocol above IP). Port numbers and protocol ID may be wildcarded. IP addresses may be wildcarded or masked by a prefix mask.
  - Special filters which look further into the packet, or require other complex operation (e.g. maintaining state) may be pre-defined in the TPF and invoked by the CRF using standardised means. Such filters may be used to support filtering with respect to a service data flow based on the transport and application protocols used above IP. This shall be possible for HTTP and WAP. This includes the ability to differentiate between TCP, Wireless-TCP according to WAP 2.0, WDP, etc, in addition to differentiation at the application level. Filtering for further application protocols and services may also be supported.
- In the case of GPRS, the traffic plane function supports simultaneous independent filtering on service data flows associated with all, and each individual active PDP contexts; that is, primary and secondary PDP contexts, of one APN.
- In case of no applicable filters for a service data flow, an operator configurable default charging should be applied. The default charging may use accounting information provided by FBC, or may use accounting

information provided by other charging mechanisms available for the IP-Connectivity Access Network (e.g. existing GPRS charging mechanisms).

- The service data flow filters and counting are applied by the TPF (the GGSN in the case of GPRS).

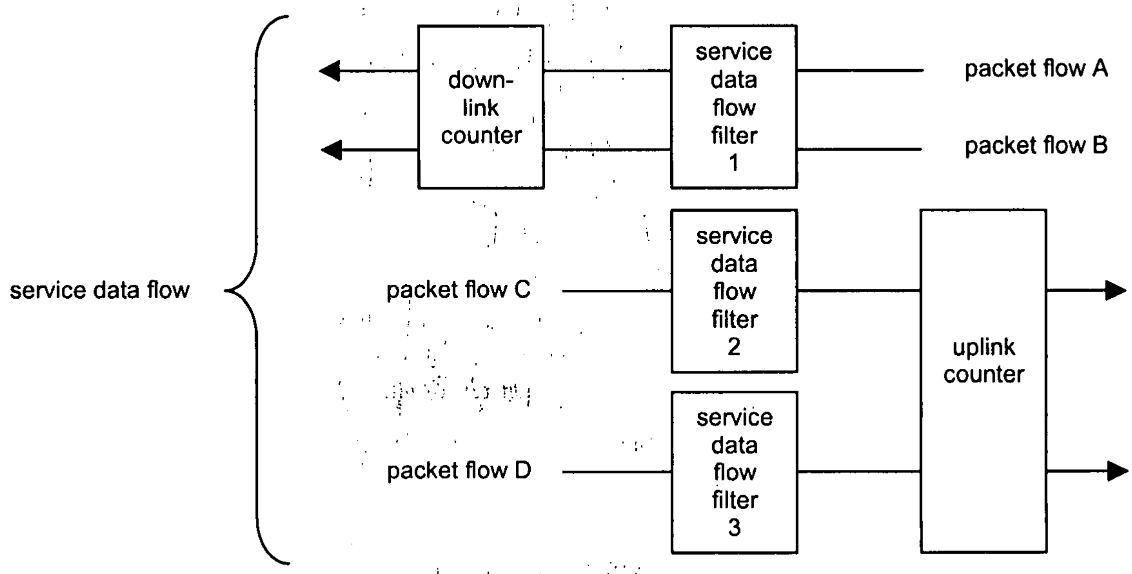


Figure 5.1 – Relationship of service data flow, packet flow and service data flow filter

5.4 Reporting

This refers to the differentiated charging information being reported to the charging functions. Basic example: those 20 packets were in rating category A, include this in your global charging information.

- The Traffic Plane function shall report bearer charging information for online charging;
- The Traffic Plane function shall report bearer charging information for offline charging;
- Charging information is reported based on the application of the bearer charging rules in the TPF (service data flow related charging information), and in the case of GPRS, as specified in [3] (per PDP context);
- It shall be possible to report charging information showing usage for each user for each charging rule, e.g. a report may contain multiple containers, each container associated with a charging key;
- It shall be possible to associate per PDP context charging information with the corresponding service data flow based charging information. It shall be possible to derive or account the data volumes per PDP context for traffic not accounted via any applicable charging rule.
  For example, in the case of GPRS, output of FBC data per charging rule on a per PDP context basis would allow non-FBC charged data volumes to be determined, and existing GPRS charging mechanisms to be applied.

Editor's Note: How online GPRS charging can be supported for packets not accounted by FBC is FFS.

5.5 Credit management

In case of online charging, it shall be possible for the OCS to apply re-authorisation of credit in case of particular events e.g. credit authorisation lifetime expiry, idle timeout, GPRS events such as SGSN change, QoS changes.

In case of online charging, credit can be pooled for multiple (one or more) charging rules applied at the Traffic Plane Function. A pool of credit applying to a single charging rule is equivalent to an individual credit limit for that charging rule. Multiple pools of credit shall be allowed per user.

Rating decisions shall be strictly controlled by the OCS for each service. The OCS shall also control the credit pooling decision for charging rules. The OCS shall either provide a new pool of credit, together with a new credit limit, or a reference to a pool of credit that already exists at the TPF.

The grouping of charging rules into pools in this way shall not restrict the ability of the OCS to do credit authorisation and provide termination action individually for each charging rule of the pool.

Note: 'credit' as used here does not imply actual monetary credit, but an abstract measure of resources available to the user. The relationship between this abstract measure, actual money, and actual network resources or data transfer, is controlled by the OCS.

It shall be possible for the OCS to group flows charged at different rates or in different units (e.g. time/volume).

Editor's note: Any impact of this requirement in relation to operation of the Gy needs to be investigated.

5.6 Termination Action

The Termination Action applies only in case of online charging. The termination action indicates the action, which the Traffic Plane Function should perform when the online charging system indicates the credit for the service data flow has expired.

The defined termination actions include:

- Dropping the packets corresponding to a terminated service data flow as they pass through the Traffic Plane Function;
- A termination action may indicate to the TPF that the default termination behaviour shall be used;
- The re-directing of packets corresponding to a terminated service data flow to an application server (e.g., defined in the termination action).

Note: such a re-direction may cause an application protocol specific asynchronous close event and application protocol specific procedures may be required in the UE and/or Application Function in order to recover, e.g., as specified in RFC 2616 for HTTP.

Default termination behaviour shall be pre-configured in the TPF according to operator's policy. For instance, a default behaviour may consist of allowing packets of the corresponding service data flow to pass through the TPF.

The OCS may provide the termination action over the Gy interface.

The Termination Action may trigger other procedures, e.g. the deactivation of a PDP context or the termination of a WLAN session.

6 Architectural concepts

6.1 Architecture

Editor's note: This clause is planned to contain the relevant part of the architecture impacted by IP flow level based charging.

6.1.1 Online service data flow based bearer charging architecture

Figure 6.1 below presents the overall architecture for service data flow based online bearer charging.

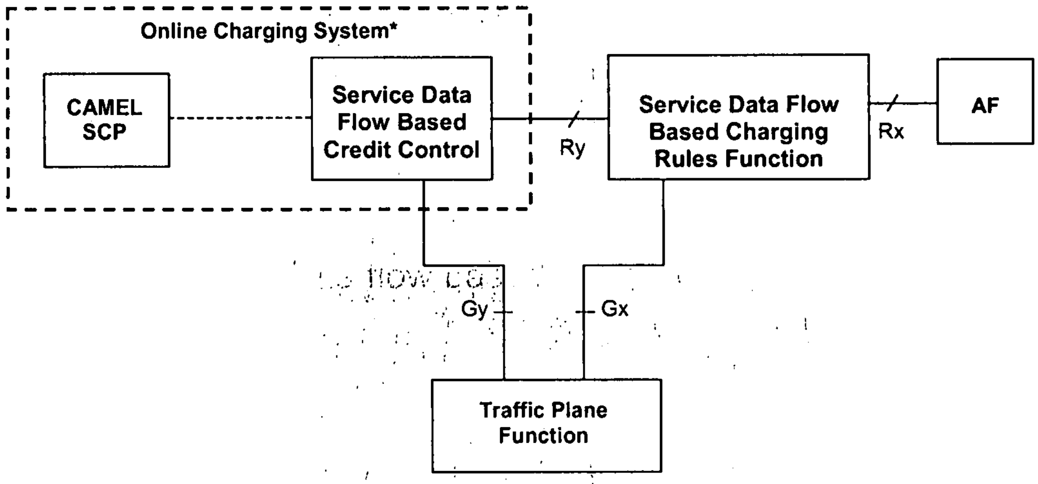


Figure 6.1: Overall architecture for service data flow based online bearer charging

Note(*): The detailed functional entities of the Online Charging System are not shown in this figure. The details of the OCS are specified in [3].
The CAMEL-SCP depicted on the figure above performs the functions as defined in [8].

6.1.2 Offline service data flow based bearer charging architecture

Figure 6.2 below presents the overall architecture for service data flow based offline bearer charging.

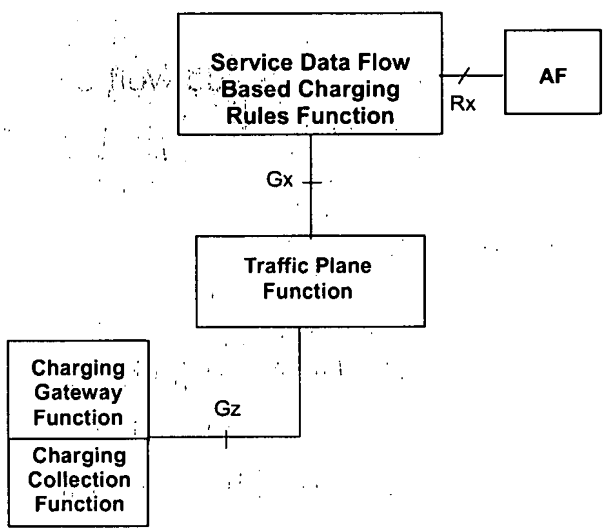


Figure 6.2: Overall architecture for service data flow based offline bearer charging

Note: The CCF depicted on the figure above performs the functions as defined in [3].

6.2 Functional Entities

6.2.1 Service Data Flow Based Charging Rules Function

The Service Data Flow Based Charging Rules Function provides service data flow level charging rules. This functionality is required for both offline and online charging. The Service Data Flow Based Charging Rules Function accesses information stored in the service data flow based charging rules data repository. An external interface to the charging rules data repository may be used for management of the charging rules within the data repository. Specification of interfaces to the data repository is out of scope of this TS.

The service data flow based charging rules function supports both static and dynamic charging rules.

The service data flow based charging rules function determines what charging rules (including precedence) to apply for a user. The applicable charging rules are determined based on information available to the CRF including that received from the Traffic Plane Function, i.e. information about the user, the bearer characteristics and whether it is an initial request or not. When a further request for charging rules from the Traffic Plane Function or information from an AF arrives the service data flow based charging rules function shall be able to identify whether new charging rules need to be transferred to the Traffic Plane Function and respond accordingly.

The service data flow based charging rules function will receive information from the application function that allows a service data flow to be identified, and this information may be used within the charging rule (i.e. protocol, IP addresses and port numbers). Other information that is received by the service data flow based charging rules function (i.e. application identifier, type of stream) may be used in order to select the charging rule to be applied.

A CRF node may serve multiple TPFs.

6.2.2 Service Data Flow Based Credit Control Function

The Service Data Flow Based Credit Control Function performs online credit control functions together with the Online Charging System. It provides a new function within the Online Charging System.

The Online Charging System is specified in 3GPP TS 32.200 [3]. The Service Data Flow Based Credit Control Function is considered as a new functional entity for release 6 within the Online Charging System.

The OCS can interact with the CRF, by using the Ry interface. This allows the OCS to provide input to the CRF for charging rules selection.

6.2.3 Charging Collection Function

The Charging Collection Function is specified in 3GPP TS 32.200 [3].

6.2.4 Traffic Plane Function

The Traffic Plane Function shall be capable of differentiating user data traffic belonging to different service data flows for the purpose of collecting offline charging data and performing online credit control.

The Traffic Plane Function shall support pre-defined charging rules, and pre-defined filters. See subclause 5.3 for further filtering and counting requirements.

For online charging, the Traffic Plane Function shall be capable of managing a pool of credit used for some or all of the service data flows of a user. The Traffic Plane Function shall also be capable of managing the credit of each individual service data flow of the user.

A TPF may be served by one or more CRF nodes. The appropriate CRF is contacted based on UE identity information.

Editor's note: The specific identity information used to identify the appropriate CRF is FFS.

For GPRS, it shall be possible to provide flow based charging functions for different service data flows even if they are carried in the same PDP Context. For GPRS, the Traffic Plane Function is a logical function allocated to the GGSN.

Editor's Note: The effects of this co-location to the interfaces still needs to be studied e.g. Gy, Gz, Gi. Gi radius extensions for charging purposes are not precluded.

For GPRS, the TPF/GGSN shall be able to do separate counts per PDP context for a single service data flow if it is transferred on more than one PDP context.

Editor's note: How this can be achieved is FFS.

For each PDP context, the TPF shall accept information during bearer establishment and modification relating to:

- The user and terminal (e.g. MSISDN, IMEISV)
- Bearer characteristics (e.g. QoS negotiated, APN)
- Network related information (e.g. MCC and MNC)

The TPF may use this information in the OCS request/reporting or request for charging rules.

For each PDP context, there shall be a separate OCS request/reporting, so this allows the OCS and offline charging system to apply different rating depending on the PDP context.

The Traffic Plane Function shall identify packets that are charged according to service data flow based charging. The Traffic Plane Function shall report the data volume(s) charged according to service data flow based charging. In case of GPRS, the Traffic Plane Function shall report the service data flow based charging data for each charging rule on a per PDP context basis.

At initial bearer establishment the Traffic Plane Function shall request charging rules applicable for this bearer from the charging rules function. As part of the request, the Traffic Plane Function provides the relevant information to the charging rules function. The Traffic Plane Function shall use the charging rules received in the response from the charging rules function. In addition, the Traffic Plane Function shall use any applicable pre-defined static charging rules. Pre-defined charging rules may apply for all users or may be activated by the CRF.

If the bearer is modified by changing the bearer characteristics relevant for the selection of the charging rules, the Traffic Plane Function shall request charging rules for the new bearer characteristics from the charging rules function.

If the Traffic Plane Function receives an unsolicited update of the charging rules from the charging rules function, the new charging rules shall be used.

If another bearer is established by the same user (e.g. for GPRS a secondary PDP context), the same procedures shall be applied by the Traffic Plane Function as described for the initial bearer.

The Traffic Plane Function shall evaluate received packets against the service data flow filters in the order according to the precedence for the charging rules. When a packet is matched against a SDF filter, the packet matching process for that packet is complete, and the charging rule for that SDF filter shall be applied.

6.2.5 Application Function

The Application Function provides information to the service data flow based charging rules function, which can then be used for selecting the appropriate charging rule, and also used for configuring some of the parameters for the charging rule. The operator configures the charging rules in the service data flow based charging rules function, and decides what data from the application function shall be used in the charging rule selection algorithm.

An AF may communicate with multiple CRFs. The AF contacts the appropriate CRF for a user at any time based on UE identity information.

Editor's note: The specific identity information used to identify the appropriate CRF is FFS.

The Application Function shall provide information to allow the service data flow to be identified. The Application Function shall also provide some other information that may be used in the charging rule selection process.

The information provided by the application function is as follows:

- Information to identify the service data flow: refer to subclause 5.3.
  The application function may use wildcards to identify an aggregate set of IP flows.

- Information to support charging rule selection:
  - Application identifier;
  - Application event identifier;
  - Type of Stream (e.g. audio, video) (optional);
  - Data rate of stream (optional).

Editor's Note: Additional information is FFS.

The "Application Identifier" is an identifier associated with each service that an AF provides for an operator (e.g. a packet streaming service application function would have one application identifier for the service).

The "Application event identifier" is an identifier within an Application identifier. It is used to notify the Service Data Flow Based Charging Rules Function of such a change within a service session that affects the charging rules, e.g. triggers the generation of a new charging rule.

6.2.6 Relationship between functional entities

The AF and the CRF need not exist within the same operator's network. The Rx interface may be intra- or inter-domain and shall support the relevant protection mechanisms for an inter-operator or third party interface.

Editor's note: It is for further study how charging rules from a home network can be supported when the TPF is in the visited network (e.g. CRF in home network communicating via CRF in visited network, CRF in home network communicating to TPF in visited network).

6.3 Reference points

6.3.1 Gx reference point

The Gx reference point enables the use of service data flow based charging rules such as counting number of packets belonging to a rate category in the IP-Connectivity Network. This functionality is required for both offline and online charging.

Note: The reuse of existing protocols over the Gi reference point for Gx shall be evaluated in stage 3.

The Gx reference point supports the following functions:

1. Initialisation and maintenance of connection
2. Request for Charging Rules (from TPF to CRF)
3. Provision of Charging Rules (from CRF to TPF)
4. Indication of Bearer Termination (from TPF to CRF)

6.3.1.1 Initialisation and Maintenance of Connection

A single connection shall be established between each interworking CRF and TPF pair. The connection can be direct, or established via a relay/proxy node. A connection may be redirected to an alternate node.

At a failover, commands which have not been successfully received shall be queued to the alternate peer.

The detail specification of the connection establishment and maintenance is for specification in stage 3.

6.3.1.2 Request for Charging Rules (from TPF to CRF)

At a bearer establishment/modification (PDP context establishment/modification for GPRS), the TPF requests the charging rules to be applied.

The request must identify whether it is an initial request (primary context establishment for GPRS), or a subsequent request (i.e. for GPRS, a secondary PDP context establishment, or a PDP context modification). For an initial request for GPRS, the request shall include APN, PDP address information, and at least one of IMSI or MSISDN. Other relevant network and terminal information should also be included.

Editor's Note: Where the relevant network and terminal information is defined is FFS (either in this TS or 32.xyz).

An identifier is required to allow the specific instance in the TPF/CRF to be identified for subsequent data exchange. The identifier for the communication must be provided.

The request must provide further information used for the charging rule selection. The request shall include an identifier for the bearer, the QoS information, and flow identifier information allocated to the bearer. For GPRS, this information would include the traffic class, and the TFT.

Where the charging rule selection data for a bearer is modified, the TPF sends the request to the CRF indicating it is for a bearer modification, and providing the modified data.

6.3.1.3 Provision of Charging Rules (from CRF to TPF)

The CRF identifies the charging rules that are applicable to the TPF. The CRF then sends the charging rule information to the TPF to be installed.

Note: The stage 3 development shall support provisioning cases where:

- charging rules are to be installed in the TPF;
- charging rules are to be removed in the TPF;
- charging rules are to be installed and removed in the TPF;
- charging rules are neither installed nor removed in the TPF (only relevant in the response to a request for charging rules).

The provisioning may be a response to a Request for Charging Rules, or it may be unsolicited.

The charging rule provision includes information about the instance it relates to (i.e. identifier for the relevant CRF/TPF instance), charging mechanism (online/offline), volume- or time-based charging indication, charging key, service data flow filter(s), and precedence.

The service data flow filters are specified separately for the uplink and downlink direction.

Note: A charging rule may provide information for service data flows for one direction, or for both directions.

6.3.1.4 Indication of Bearer Termination (from TPF to CRF)

The TPF indicates to the CRF that a bearer is terminated.

The bearer termination indication includes information to identify the instance it relates to (i.e. an identifier for the relevant CRF/TPF instance), and an indication of the bearer being removed (the PDP context in the case of GPRS). The termination also indicates if this is the last bearer for that TPF/CRF instance.

6.3.2 Gy reference point

The Gy reference point allows credit control for service data flow based online charging. The functionalities required across the Gy reference point use functionalities and mechanisms specified for the release 5 Ro interface.

The Ro interface is specified for release 5 in TS 32.200 [3] and TS 32.225 [7].

6.3.3 Gz reference point

The Gz reference point enables transport of service data flow based offline charging information.

For GPRS the relationship of the Gz reference point and the existing Ga interface is subject to investigation in SA5.

The Ga interface is specified by TS 32.200 [3].

6.3.4 Rx reference point

6.3.4.1 General

The Rx reference point enables transport of information (e.g. dynamic media stream information) from the application function to the charging rules function. An example of such information would be filter information to identify the packet flow.

6.3.4.2 Initialisation and Maintenance of Connection

A single connection shall be established between each interworking CRF and AF pair. The connection can be direct, or established via a relay/proxy node. A connection may be redirected to an alternate node.

At a failover, commands which have not been successfully received shall be queued to the alternate peer.

The detail specification of the connection establishment and maintenance is for specification in stage 3.

6.3.5 Ry reference point

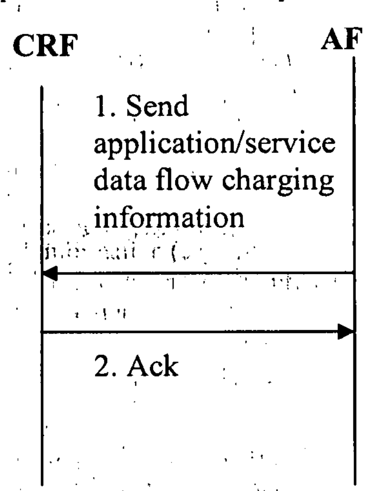
The Ry reference point enables transport of information (e.g. charging rules selection information) from the OCS to the charging rules function. The functionality supported over the Ry reference point should be the same as for the Rx reference point and a common interface specification is expected.

7 Message Flows

Editor's note: This clause is planned to contain the description of new and modified information flows.

7.1 AF input to provision of charging rules

The AF may provide the CRF with application/service data flow charging information. This information is used by the CRF to determine and complete the appropriate charging rules to send to the TPF. It is an AF decision when to send this information and the CRF takes the AF input into account from the point that it receives the AF information.



1. The AF sends application/service data flow charging information
2. The CRF acknowledges the AF input.

7.2 Bearer events

7.2.1 Bearer Service Establishment

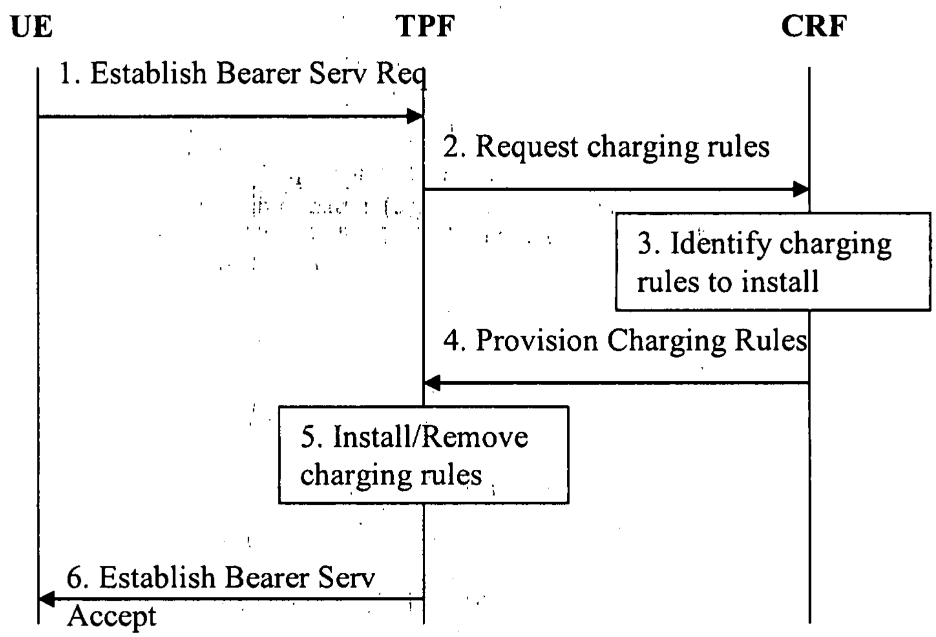


Figure 7.1: Bearer Service Establishment

1 The TPF receives a request to establish a bearer service. For GPRS, this is the GGSN that receives a Create PDP context request for a primary or secondary PDP context.

2 The TPF requests the applicable charging rules, and provides relevant input information for the charging rule decision.

3 The CRF determines the charging rules to be provisioned, based on information available to the CRF (e.g. information may be available from the AF as described in 7.1 and the new information received from the TPF). Charging rules may need to be added, and/or removed.

4 The CRF provides the charging rules to the TPF. This message is flagged as the response to the TPF request.

5 The TPF installs/removes the charging rules as indicated.

6 The TPF continues with the bearer service establishment procedure.

Editor's Note: It is FFS whether the bearer service establishment procedure can proceed in parallel with the charging rules request.

7.2.2 Bearer Service Modification

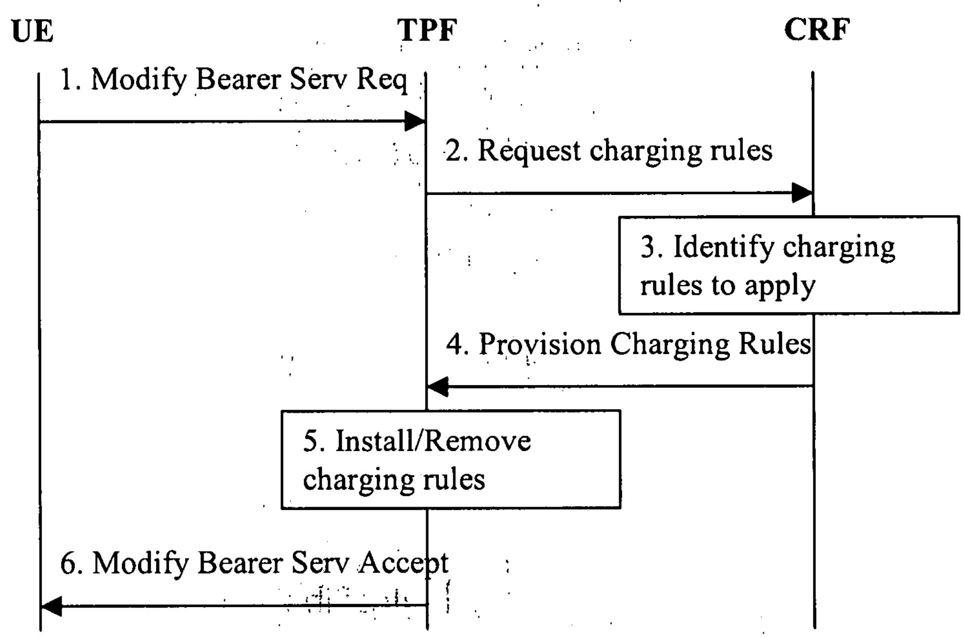


Figure 7.2: Bearer Service Modification

1 The TPF receives a request to modify a bearer service. For GPRS, the GGSN receives an Update PDP context request.

2 The TPF requests the applicable charging rules, and provides relevant input information for the charging rule decision.

3 The CRF determines the charging rules to be provisioned, based on information available to the CRF (e.g. information may be available from the AF as described in 7.1 and the new information received from the TPF). Charging rules may need to be added, and/or removed.

4 The CRF provides the charging rule information to the TPF. This message is flagged as the response to the TPF request.

5 The TPF installs/removes the charging rules as indicated.

6 The TPF continues with the bearer service modification procedure.

Note: In the case of GPRS, the modification of the bearer service may also be initiated by other nodes such as the SGSN.

Editor's Note: It is FFS whether the bearer service modification procedure can proceed in parallel with the charging rules request.

7.2.3 Bearer Service Termination

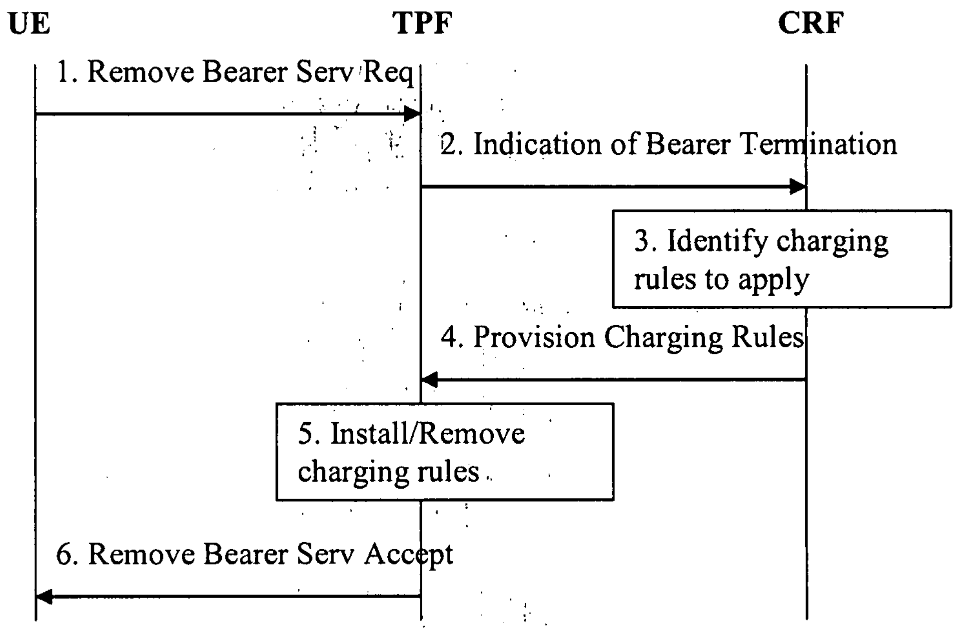


Figure 7.3: Bearer Service Termination

1 The TPF receives a request to remove a bearer service. For GPRS, this is the GGSN that receives a delete PDP context request.

2 The TPF indicates that a bearer (for GPRS, a PDP context) is being removed and provides relevant input information for the charging rule decision.

3 The CRF determines the charging rules to be provisioned, based on information available to the CRF (e.g. information may be available from the AF as described in 7.1 and the new information received from the TPF). Charging rules may need to be added, and/or removed.

4 The CRF provides the charging rule information to the TPF. This message is flagged as the response to the TPF request.

5 The TPF installs/removes the charging rules as indicated.

6 The TPF continues with the bearer service removal procedure.

Note: In the case of GPRS, the bearer service termination procedure may also be initiated by other nodes such as the SGSN.

Editor's Note: It is FFS whether the bearer service termination procedure can proceed in parallel with the indication of bearer termination.

7.3 Provision of Charging Rules triggered by other event to the CRF

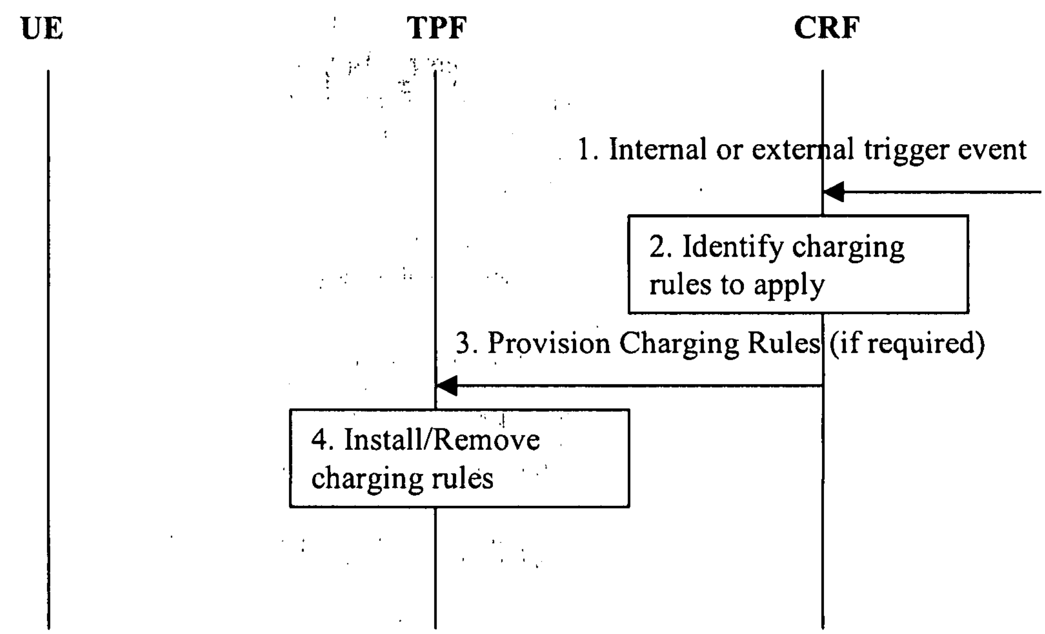


Figure 7.4: Provision of Charging Rules due to external or internal Trigger Event

1 The CRF receives a trigger event, with relevant information related to the event. One example event is an AF interaction as described in 7.1.

2 The CRF determines the charging rules to be added/removed, based on information available to the CRF (e.g. information may be available from the AF as described in 7.1 and the new information received from the trigger). Charging rules may need to be added, and/or removed.

3 If required, the CRF provisions the charging rules to the TPF.

4 The TPF installs/removes the charging rules as indicated.

Annex A (informative): Overall architectural impacts of IP flow based charging

A.1 GGSN in HPLMN

One of the underlying drivers for the IP flow charging work is to permit greater flexibility in PS domain charging, and, to control this flexibility in the HPLMN. This is a fairly fundamental change from the concepts that lead to development of the CAMEL 3 standards (which provide the capability for pre-pay charging on the SGSN) and some aspects of the IMS architecture (e.g. P-CSCF and I-CSCF).

This movement towards charging in the "GGSN arena" rather than "charging at the SGSN" leads to a few questions:

a) is all the information that the SGSN places on the S-CDR available at the GGSN? If not, what is missing, is it important, and, can GTP be upgraded to provide it to the GGSN?

b) when this information is passed to the GGSN, can it then be made available as extra Radius parameters?

c) does this information need to be sent on the Gx and/or Gy and/or Gz interfaces?

A.2 Comparison of S-CDR and G-CDR fields

A.2.1 S-CDR information missing from G-CDR

The following fields are present in the S-CDR but absent from the G-CDR

- Served IMEI;
- MS Network Capability;
- LAC/RAC/CI at "record opening";
- Access Point Name Operator Identifier;
- System Type;
- CAMEL information;
- RNC unsent data volume.

These parameters are analysed further in the following subsections.

A.2.2 Served IMEI

This information is useful for many operational/statistical purposes within the HPLMN. Examples might include checking whether the SIM-IMEI combination "is correct"; which brands of mobile generate what proportion of revenue streams and/or access particular types of services; etc.

Hence it is recommended to provide the IMEISV to the GGSN for transparent transfer within the GGSN to the G-CDR and/or Radius attribute. This means the addition of an optional parameter to the Create PDP Context Request message.

Note that the IMEISV should be provided rather than just the IMEI because the SV information has some value, and, IMEISV is as equally easy for the SGSN to obtain as the IMEI.

A.2.3 MS Network Capability

This is the "core network" part of the mobile's classmark. Review of 24.008 shows that most of the really interesting information for the HPLMN is contained within the Radio Classmark information and not within the MS Network Capability. However, the Radio Classmark information is not included on the S-CDR.

Hence statistical information gathering (such as, what proportion of UK data traffic is carried by mobiles that support the PCS 1900 spectrum) has to be gathered from analysis of IMEIs rather than analysis of the Classmark field.

Hence, provided IMEISV is sent to the GGSN, this field need not be sent to the GGSN.

A.2.4 LAC/RAC/CI at "record opening"

Various tariffs can be imagined that use cell ID information (e.g. a home cell tariff, whereby, if the context is opened in your home cell, a certain volume of data is charged at a lower rate). Statistical information gathering is also performed on a per cell basis.

Hence knowledge of the "full" cell ID at the GGSN would be useful.

Note that the "full" cell ID includes the MNC and MCC – but these fields have recently been added to R'97 and R'99 GTP. During the debate on this topic, it might have been argued that the 3G-SGSN did not know the Service Area Code where the mobile was activating the PDP context. However, this seems to be incorrect, because study of RANAP shows that the RNC is required to add the mobile's current SAI to every Direct Transfer message sent to the SGSN,

There may be some concerns about sending cell-ID information between networks, however, it may well already be sent in the inter-operator TAP records! Also, as a "ball park figure", 90% of subscribers are in their home network and 10% are roaming abroad, and the main usage of this field would be for the 90% of subscribers in their HPLMN.

So, it seems useful to add CGI/SAI information into the GTP signalling.

Further complexity arises however from the phrase "at record opening". In both SGSN and GGSN, it is possible to raise partial CDRs. A "partial CDR" is potentially generated every 15 minutes and reduces the fraud risks associated with only generating a full CDR after many mega bytes have been sent on a PDP context that has been open for several days. From reading 32.215 it seems that the Cell ID needs to be inserted into the S-CDR every time a partial CDR is opened.

Full support of the Cell ID in Partial G-CDRs appears difficult, however, a useful compromise would seem to be to add CGI/SAI information to all GTP messages that can be sent by the SGSN as a result of receiving a RANAP Direct Transfer message. When the mobile is using the Gb interface, the SGSN should add the CGI to these messages.

Hence it is recommended to add CGI/SAI as an optional parameters in the following GTP messages:

- Create PDP Context Request;
- Update PDP Context Request.

Whether or not the CGI/SAI is included by the SGSN should be controlled by the SGSN operator according to the PLMN-ID of the GGSN.

A.2.5 Access Point Name Operator Identifier

Section 14.13 of 3GPP TS 23.060 states that this field is part of the APN and that the APN is used to identify the GGSN. As such, it is logical that this field is included on the S-CDR.

However, there appears to be absolutely no need to transfer this field to the GGSN.

A.2.6 System Type

On the S-CDR, this indicates whether the SGSN serves 2G or 3G cells. There is no code point for a combined 2G/3G SGSN, and no indication as to whether or not the combined SGSN has separate 2G and 3G Routeing Areas!

It is recommended to add an "SGSN type" information element to the following GTP messages:

- Create PDP Context Request;
- Update PDP Context Request.

The contents of the "SGSN type" information element should be able to encode the following information, and permit future backwards compatible extension:

- 2G only SGSN;
- 3G only SGSN;
- Combined 2G/3G SGSN with all 2G cells in separate Routeing Areas to 3G cells;
- Combined 2G/3G SGSN with some 2G and 3G cells in the same Routeing Area.

Future additions might be needed to add in UMTS FDD/TDD differentiation, or if new Radio Access Technologies are adopted in the future.

Note that this "SGSN type" is different to the current "System type" field on the S-CDR. Whether or not the "System type" field on the S-CDR should be updated is FFS.

A.2.7 CAMEL information

Some CAMEL functionality relates to SGSN based on-line charging. When using SGSN based on-line charging, GGSN based on-line charging is unlikely to also be used. However, other CAMEL functionality relates to APN ID manipulation; SGSN resource utilisation, and the provision for the gsmSCF to write a "free format field" to the main CDR. This information appears to be useful to transfer to the GGSN.

Overall it appears simplest to transfer all the S-CDR CAMEL Information as one parameter from the SGSN to the GGSN. The format and encoding of this information element should be constructed in an extensible manner, hopefully by just referencing the encoding already used within 3GPP TS 32.215.

This information element should be included in the Create PDP Context Request and Update PDP Context Request messages.

A.2.8 RNC unsent data volume

If this information is useful to an SGSN, then it should be passed to the GGSN. In doing so it needs to be supplemented by the "2G SGSN unsent data volume". Probably the unsent data volume could be accumulated by the new SGSN and sent to the GGSN at PDP context release. Providing this information to the new SGSN at inter SGSN change may require new GTP messages. Obtaining the information from the RNC may require additional use of existing RANAP signalling procedures.

However, as the value of sending this information from the RNC to the SGSN is as yet unclear, so far it is not agreed to add this information into the GTP signalling.

A.3 RADIUS attributes

With the provision of the above information to the GGSN, then if RADIUS accounting is applied in the operator's network then it is recommended that the following RADIUS attributes are added to the appropriate RADIUS messages:

- IMEISV;
- CGI/SAI;
- SGSN type;
- CAMEL information.

Annex B (informative): IMS and Flow based charging

Flow Based Charging offers other ways that IMS service may be charged. Considering this, we need to study the usage of Flow Based Charging in relation to IMS.

The following needs to be studied:

1. Flow Based Charging needs to provide a solution to the issues solved by Rel5 IMS correlation, considering issues such as backwards compatibility.

2. It needs to be clarified whether having multiple filters provided to the GGSN (over Go and Gx) is an issue (and if it is, it needs to be resolved).

3. How charging rules can be applied to the SIP signalling used for IMS session control

B.1 IMS SIP signalling

This section studies how flow based charging can be applied to the IMS signalling used for IMS session control.

It is to be noted though that the SIP signalling itself could carry different type of information that may be charged differently (e.g. SIP Session Invites, IMS messaging, etc.).

Possible ways to charge SIP at the bearer level could consist of:

- Applying pre-configured static rules in the TPF;
- Requesting charging rules from the CRF;
- Updating charging for the IMS signalling charging rules based specific triggers (e.g. time of day, modification of the session parameters, etc.) for a given user.

Note: the usage of the signalling indication needs to be further studied with respect to Flow Based Charging.

B.2 Rx/Gx functions and SBLP usage

Dynamic media stream filter information for QoS policy and charging correlation may be provided to the GGSN via the Gq and Go interfaces. This is described in TS 23.207 and TR 23.917.

Dynamic and static media stream filter information for charging (data for the charging rules) may be provided to the Traffic Plane Function (GGSN in the case of GPRS) via the Rx and Gx interfaces. This is described in this TS.

These two functions are independent and thus can be provided separately.

Annex C (informative): WLAN and flow based charging

C.1 TPF usage for WLAN

For WLAN, the current working assumption is that the TPF is a logical function allocated to the PDG. It is FFS how this will be impacted by the ongoing WLAN/3GPP architecture work.

Annex D (informative): Change history

Change history							
Date	TSG #	TSG Doc.	CR	Rev	Subject/Comment	Old	New
2004-01					Initial base		0.0.1
2004-01					Moved text from TR 23.825 v 1.4.0, editorial changes	0.0.1	0.1.0
2004-02					Updated with approved contributions from SA2#38 (Atlanta): S2-040695, S2-040696, S2-040700, S2-040701, S2-040702, S2-040703, S2-040705, S2-040706, S2-040707, S2-040708, S2-040963, S2-040964, S2-040965, S2-041027	0.1.0	0.2.0
2004-02					Editorial changes in chapter 7.1 and annex D	0.2.0	0.2.1
2004-03	SA #23	SP-040050			Presentation to SA #23 plenary for approval	0.2.1	2.0.0
2004-03	SA #23	SP-040050			Raised to v.6.0.0 after approval at SA#23 (same content as previous version)	2.0.0	6.0.0

3GPP TR 23.825 V1.1.0 (2003-11)

Technical Report

3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; Overall Architecture Aspects of IP Flow Based Bearer Level Charging; Stage 2 (Release 6)

GLOBAL SYSTEM FOR MOBILE COMMUNICATIONS

Remove GSM logo from the cover page for pure 3rd Generation documents.

Select keywords from list provided in specs database.

Keywords

<keyword[, keyword]>

3GPP

Postal address

3GPP support office address

650 Route des Lucioles - Sophia Antipolis
Valbonne - FRANCE
Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16

Internet

http://www.3gpp.org

Contents

Foreword

This Technical Report has been produced by the 3rd Generation Partnership Project (3GPP).

The contents of the present document are subject to continuing work within the TSG and may change following formal TSG approval. Should the TSG modify the contents of the present document, it will be re-released by the TSG with an identifying change of release date and an increase in version number as follows:

Version x.y.z

where:

x the first digit:

1 presented to TSG for information;

2 presented to TSG for approval;

3 or greater indicates TSG approved document under change control.

y the second digit is incremented for all changes of substance, i.e. technical enhancements, corrections, updates, etc.

z the third digit is incremented when editorial only changes have been incorporated in the document.

Introduction

This clause is optional. If it exists, it is always the second unnumbered clause.

1 Scope

The present document identifies the overall architecture aspects of IP flow based bearer level charging.

It is expected that the content of this TR will act as a basis for:

- Change requests against the architecture specifications [5] of SA2, clarifying the architecture implications of IP flow based bearer charging
- Change requests against the Charging Principles specification [3] of SA5, which contains the charging architecture and mechanisms.

2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document.*

[1] 3GPP TR 41.001: "GSM Release specifications".

[2] 3GPP TS 21.905: "Vocabulary for 3GPP Specifications".

[3] 3GPP TS 32.200: "Charging Principles".

[4] 3GPP TS 23.228: "IP Multimedia (IM) Subsystem - Stage 2".

[5] 3GPP TS 23.002: "Network architecture".

[6] 3GPP TS 23.060: "General Packet Radio Service (GPRS); Service description; Stage 2".

3 Definitions, symbols and abbreviations

3.1 Definitions

For the purposes of the present document, the terms and definitions given in TS 21.905 [2] and the following apply:

Editor's note: terms shown in <angle brackets> are provisional.

Packet flow: a specific user data flow carried through the Traffic Plane Function.

Service data flow: aggregate set of packet flows. A packet flow can be an IP flow.

In the case of GPRS, it shall be possible that a service data flow is more granular than a PDP context.

Service Data Flow Filter: a set of filter parameters used to identify one or more of the packet flows constituting a service data flow. At least the following means for the packet flow identification shall be supported: source and destination IP address+port, transport protocol, or application protocol.

Charging rule: data that identifies the service data flow filters, charging key, and the associated charging actions, for a single service data flow.

Charging key: information used by the online and offline charging system for rating purposes. The charging key is an identifier associated with the charging rule that is unique within the charging rules for that users IP address/prefix.

Dynamic charging rules: Charging rules where some of the data within the charging rule (e.g. service data flow filter information) is assigned via real-time analysis which may use dynamic application derived criteria.

Static charging rules: Charging rules where all of the data within the charging rule describing the service data flow is permanently configured throughout the duration of a user's data session. Static charging rules may be activated dynamically.

Predefined charging rules: Static charging rules which are defined in the Traffic Plane Function.

3.2 Symbols

For the purposes of the present document, the following symbols apply:

<symbol> <Explanation>

3.3 Abbreviations

For the purposes of the present document, the following abbreviations apply:

AF	Application Function
BS	Billing System
CCF	Charging Collection Function
CDR	Charging Data Records
CGF	Charging Gateway Function
CRF	Charging Rules Function
CSCF	Call Session Control Function
ECF	Event Charging Function
GCID	GPRS Charging ID
GGSN	Gateway GPRS Support Node
GPRS	General Packet Radio Service
HPLMN	Home PLMN
HTTP	Hypertext Transfer Protocol
ICID	IMS Charging Identifier
IM	IP Multimedia
IM CN SS	IP Multimedia Core Network Subsystem
IMS	IP Multimedia Core Network Subsystem
IMSI	International Mobile Subscriber Identity
OCS	Online Charging System
P-CSCF	Proxy-CSCF
PDGw	Packet Data Gateway
PLMN	Public Land Mobile Network
PSTN	Public Switched Telephone Network
QoS	Quality of Service
S-CSCF	Serving-CSCF
SGSN	Serving GPRS Support Node
SIP	Session Initiation Protocol
TPF	Traffic Plane Function
UE	User Equipment
WAP	Wireless Application Protocol
WLAN	Wireless LAN

4 General Charging Architecture Requirements

Editor's note: This clause is planned to contain the relevant architecture requirements related to IP flow level charging.

4.1 General

The current level of traffic differentiation and traffic-type awareness of the GPRS architecture shall be extended beyond APN and PDP Context level. It shall be possible to apply differentiated charging for the traffic flows belonging to different services (a.k.a. different service data flows) even if they use the same PDP Context.

Charging and tariffing models described in this Technical Report shall be possible to be applied to both prepaid and postpaid subscribers, i.e. to both online and offline charging.

The GPRS online charging solutions up to release 5 are built around CAMEL mechanisms that provide online access- and charging-control for GPRS - pertaining to PDP Contexts of an APN.

The evolved bearer charging architecture developed in this Technical Report shall use generic native IP charging mechanisms to the extent possible in order to enable the reuse of the same charging solution and infrastructure for different type of IP-Connectivity Networks.

Note: Providing differentiated service-data flow-based charging is a different function from providing differentiated traffic treatment on the IP-flow level. The operation of service-data flow-based charging shall not mandate the operation of service-based local policy. At the same time, the relationship of the PDP Context based service-based local policy mechanisms of the Go interface and the service data flow based charging mechanisms will have to be carefully studied.

The following new release 6 functions need to be provided by the network for service data flow based charging:

- Identification of the service data flows that need to be charged at different rates
- Provision and control of service data flow level charging rules
- Reporting of service data flow level packet counts for offline and online charging
- Event indication according to on-line charging procedures (e.g. sending AAA Accounting Stop) and, optionally, following this particular event, taking appropriate actions on service data flow(s) according to the termination action defined in the respective charging rule(s).

These new functions shall be compatible and coherent with the authentication, authorization, PDP context management, roaming and other functions provided by the existing architecture.

In addition charging based on specific application services or protocols shall be supported.

4.2 Traffic Plane Function

This refers to the filtering that identifies the service data flows that need to be charged at different rates. Basic example: look for packets to and from service A.

- Different filtering and counting shall be supported for downlink and uplink.
- Different granularity for service data flow filters identifying the service data flow shall be possible e.g.
    - Filters based on the IP 5 tuple (source IP address, destination IP address, source port number, destination port number, protocol ID of the protocol above IP). Some of the filter parameters may be wildcarded.
    - Supporting filtering with respect to service data flow based on the transport and application protocols used above IP shall be possible for HTTP and WAP. This includes the ability to differentiate between TCP, Wireless-TCP according to WAP 2.0, WDP, etc, in addition to differentiation at the application level. Filtering for further application protocols and services may also be supported.

- In the case of GPRS, the traffic plane function shall provide the ability to support simultaneous independent filtering on service data flows associated with all, and each individual active PDP contexts; that is, primary and secondary PDP contexts, of one APN.
- In case of no applicable filters for a service data flow, an operator configurable default charging should be applied.

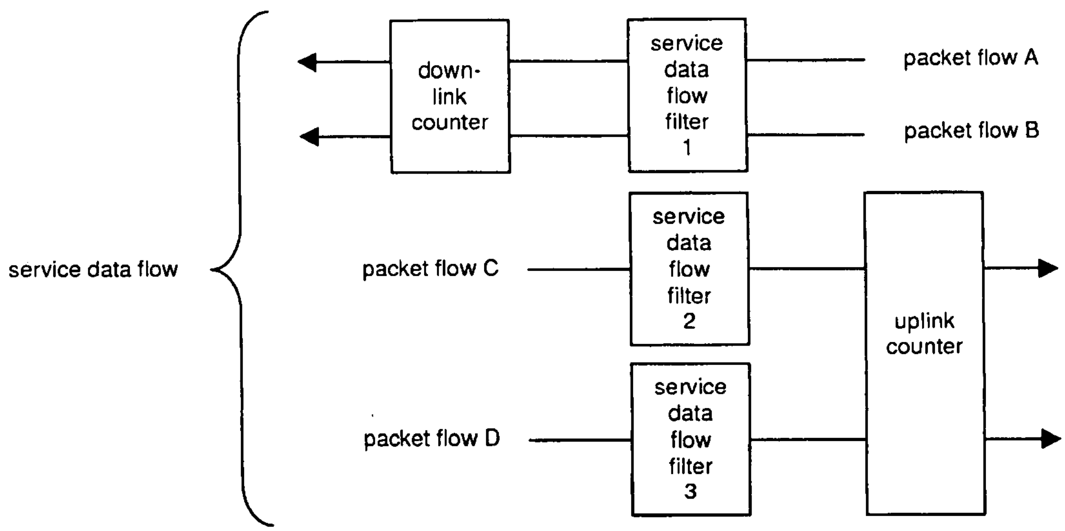


Figure 4.2 – Relationship of service data flow, packet flow and service data flow filter

4.3 Charging rules

Charging rules contain information that allow for filtering of traffic to identify the packets belonging to a particular service data flow, and allow for defining how the service data flow is to be charged. The following apply to charging rules:

- Charging rules for bearer charging shall be defined by the operator.
- These charging rules shall be made available to the Traffic Plane function for both offline and online charging.
- Multiple charging rules shall be supported.
- Filtering information within a charging rule is applied through filtering functionality at the Traffic Plane Function to identify the packets belonging to a particular service data flow.
- Charging rules with statically provisioned filtering information (i.e. pre-defined at the Traffic Plane Function) shall be supported
- Charging rules with dynamically provisioned filtering information (i.e. made available to the Traffic Plane Function) shall be supported in order to cover IP service scenarios where the filtering information is dynamically negotiated (e.g. negotiated on the application level (e.g. IMS)).
- Pre-defined charging rules shall be supported.

Editor's Note: Specifying the application of static rules (eg. static rules for all users, static rules per user) is FFS.

- There may be overlap between the charging rules that are applicable. Overlap can occur between:
    - multiple pre-defined charging rules in the TPF

- charging rules pre-defined in the TPF and rules from the Service Data Flow Based Charging Rules Function, which can overlay the pre-defined rules in the TPF

  The precedence identified with each charging rule shall resolve all overlap between the charging rules.

- Charging rules contain information on
  - How a particular service data flow is to be charged: online/offline
  - In case of offline charging whether to record volume- or time-based charging information
  - In case of online charging, what termination action is to be applied
  - Charging key
  - Service data flow filter(s)
  - Precedence
- Elements of charging rules may either be statically configured at the Traffic Plane Function, or may be dynamically provisioned.

Note: The mechanism to support use of elements statically pre-defined in the TPF (e.g. filter information) is for stage 3 development.

- Once the charging rule is determined it is applied to the service data flow at the Traffic Plane Function and packets are counted and categorised per the rule set in the charging rule.
- Different charging rules shall be supported in downlink and uplink.
- Charging rules shall be available for both user initiated and network initiated flows.
- Charging rules can change and be overridden, for a previously established PDP context in the GPRS case, based on specific events (e.g. IM domain events or GPRS domain events).
- It shall be possible to apply different charging rules for different users or groups of users.
- It shall be possible to apply different charging rules based on the location of the user (e.g. based on identity of the roamed to network).
- Overlap between charging rules (whether static or dynamic) applied for a user shall be identified, and resolved according to operator specified rules.
- For GPRS, charging rule assignment shall be possible at PDP context establishment.
- For GPRS, it shall be possible to have different charging rules depending on the APN used.

4.3.1 Termination Action

Termination Action applies in case of online credit control, each charging rule has a corresponding termination action defined for service data flows that are online charged. The termination action indicates the action which the Traffic Plane Function should perform when the on-line charging system causes the Diameter Credit Control Client to terminate a service data flow.

This clause defined the termination action at the Traffic Plane Function. Termination Actions may also be defined in the OCS.

The defined termination actions include:

- Drop the packets corresponding to a terminated service data flow as they pass through the Traffic Plane Function.

Additional termination actions such as re-directing packets corresponding to a terminated service data flow are to be investigated

No termination action means that the packets corresponding to a terminated service data flow will be allowed to pass through the Traffic Plane Function. The charging actions in this case are FFS.

The Termination Action may trigger other procedures, e.g. the deactivation of a PDP context or the termination of a WLAN session.

4.3.2 Credit management

In case of online charging, it shall be possible to:

1. have a pool of credit/resource used for multiple charging rules applied at the Traffic Plane Function.
2. have individual credit/resource limits for each charging rule applied at the Traffic Plane Function

Rating decisions shall be strictly controlled by the OCS for each service.

Note: 'credit' as used here does not imply actual monetary credit, but an abstract measure of resources available to the user. The relationship between this abstract measure, actual money, and actual network resources or data transfer, is controlled by the OCS.

4.4 Reporting

This refers to the differentiated charging information being reported to the existing charging architecture. Basic example: those 20 packets were in rating category A, include this in your global charging information.

- The Traffic Plane function shall report bearer charging information for online
- The Traffic Plane function shall report bearer charging information for offline
- It shall be possible to collect charging information based on the bearer charging rules (service data flow related charging information), and in the case of GPRS, release 5 charging rules (per PDP context)
- It shall be possible to report charging information showing usage for each user for each charging rule, e.g. a report may contain multiple containers, each container associated with a charging key.

4.5 Backwards compatibility

The enhanced architecture shall be backwards compatible with release 5 charging capabilities.

4.6 Charging models

When developing the charging solutions, the following charging models should be considered, even though the full solution to support the models may not be within the scope of this TR.

Shared revenue services shall be supported. In this case settlement for all parties shall be supported, including the third parties that may have been involved providing the services.

Charging models where service data flow charging depends on the volume of data or the duration of the session shall be supported, as well as those where service data flow charging depends on the time of day.

It shall be possible to restrict special rates to a specific service, e.g. allow the user to download a certain volume of data from one service for free, but this allowed volume is not transferable to other services.

In the case of online charging, and where information is available to enable service data flow packets to be associated with a specific PDP context, it shall be possible to perform rating and allocate credit depending on the characteristics of the resources allocated initially (in the GPRS case, the QoS of the PDP context).

The flow based bearer level charging can support dynamic selection of charging to apply. A number of different inputs can be used in the decision to identify the specific charging to apply. For example, a service data flow may be charged with different rates depending on what QoS is applicable. The charging rate may thus be modified when a bearer is created or removed, to change the QoS provided for a flow.

The charging rate or charging model applicable to a flow may also be changed as a result of a events in the service (eg insertion of a paid advertisement within a user requested media stream).

5 Architectural Concept

5.1 Architecture and Reference Points

Editor's note: This clause is planned to contain the relevant part of the architecture impacted by IP flow level based charging.

5.1.1 Online service data flow-based bearer charging architecture

Figure 5.1 below presents the overall architecture for service data flow-based online bearer charging.

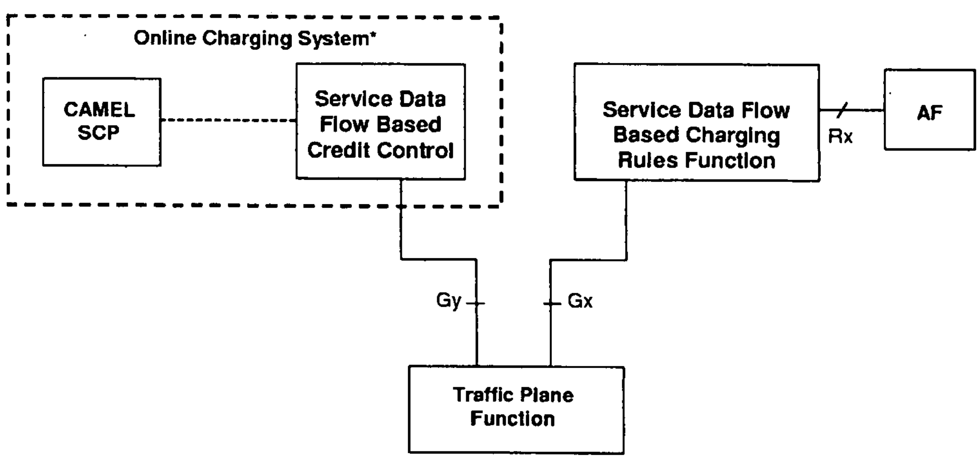


Figure 5.1 – Overall architecture for service data flow based online bearer charging

Note: No changes are foreseen on the CAMEL SCP. The relation of the new entities and interfaces described in this figure to existing entities and interfaces of the 3GPP system architecture (e.g. SGSN, GGSN) are FFS.

Note(*): The detailed functional entities of the Online Charging System are not shown in this figure. The details of the OCS are specified in TS 32.200, further internal details of the OCS for release 6 are expected to be specified by SA5.
The CAMEL-SCP depicted on the figure above performs the functions of the Rel-5 Bearer Charging Function defined in TS32.200.

5.1.2 Offline service data flow-based bearer charging architecture

Figure 5.2 below presents the overall architecture for service data flow-based offline bearer charging.

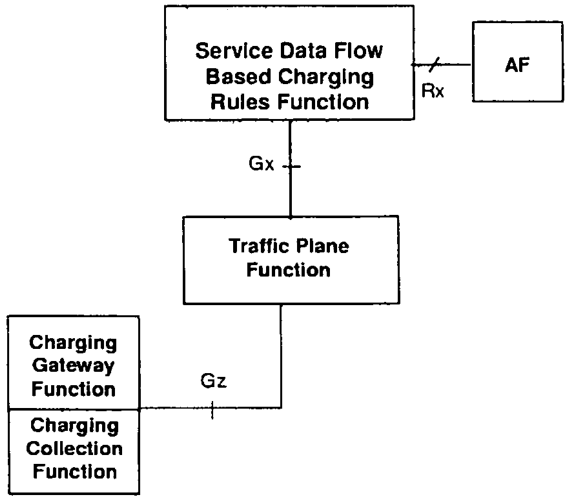


Figure 5.2 – Overall architecture for service data flow based offline bearer charging

Note: No changes are foreseen on the CCF. The relation of the new entities and interfaces described in this figure to existing entities and interfaces of the 3GPP system architecture (e.g. SGSN, GGSN) are FFS.

5.2 Functional Entities

Editor's note: This clause is planned to contain the description of new and modified functional entities.

5.2.1 Service Data Flow Based Charging Rules Function

This entity provides service data flow level charging rules. This same functionality is required for both offline and online charging. The charging rules function accesses information stored in the service data flow based charging rules data repository. An external interface to the charging rules data repository may be used for management of the charging rules within the data repository. Specification of interfaces to the data repository is out of scope of this TR.

The service data flow based charging rules function supports both static and dynamic charging rules.

The service data flow based charging rules function determines what charging rules including precedence to apply for a user.

The service data flow based charging rules function will receive information from the application function that allows the service data flow to be identified, and this information may be used within the charging rule (i.e. protocol, ip addresses and port numbers). Other information that is received by the service data flow based charging rules function (i.e. application identifier, type of stream) may be used in order to select the charging rule to be applied.

5.2.2 Service Data Flow Based Credit Control Function

The Service Data Flow-Based Credit Control Function performs online credit control functions together with the Online Charging System. It provides a new function within the release 5 Online Charging System.

The Online Charging System is specified in 3GPP TS 32.200. The Service Data Flow Credit Control Function is considered as a new functional entity for release 6 within the Online Charging System.

5.2.3 Charging Collection Function

The Charging Collection Function is specified in 3GPP TS 32.200.

The service data flow based charging requires no changes in the CCF.

5.2.4 Traffic Plane Function

The Traffic Plane Function shall support pre-defined charging rules.

The Traffic Plane Function shall be capable of differentiating user data traffic belonging to different service data flows for the purpose of collecting offline charging data and performing online credit control.

See section 4.2 for requirements of the Traffic Plane Function.

For online charging, the Traffic Plane Function shall be capable of managing the aggregation of the credit/resource used for some or all of the service data flows of a user. The Traffic Plane Function shall also be capable of managing the credit/resource of each individual service data flow of the user.

For GPRS, it shall be possible to provide these functions for different service data flows even if they are carried in the same PDP Context. For GPRS, the traffic Plane Function is a logical function allocated to the GGSN.

Editor's Note: The effects of this co-location to the interfaces still needs to be studied eg. Gy, Gz, Gi. Gi radius extensions for charging purposes are not precluded.

The Traffic Plane Function shall evaluate received packets against the service data flow filters in the order according to the precedence for the charging rules. When a packet is matched against a SDF filter, the packet matching process for that packet is complete, and the charging rule for that SDF filter shall be applied.

Editor's Note: The relationship of the Traffic Plane Function and WLAN interworking nodes (e.g. WLAN PDGw) is FFS.

5.2.5 Application Function

The application function provides information to the service data flow based charging rules function, which can then be used for selecting the appropriate charging rule, and also used for configuring some of the parameters for the charging rule. The operator configures the charging rules in the service data flow based charging rules function, and decides what data from the application function shall be used in the charging rule selection algorithm.

The Application Function shall provide information to allow the service data flow to be identified. The Application Function shall also provide some other information that may be used in the charging rule selection process.

The information provided by the application function is as follows:

- Information to identify the service data flow. This shall include the following fields:
  - Protocol
  - Source and destination IP address
  - Source and destination port number

  The application function may use wildcards to identify an aggregate set of IP flows.

- Information to support charging rule selection:
  - Application identifier
  - Application event identifier
  - Type of Stream (e.g. audio, video) (optional)
  - Data rate of stream (optional)

Editor's Note: Additional information is FFS.

The "Application Identifier" is an identifier associated with each service that an AF provides for an operator (e.g. a PSS application function would have one application identifier for the PSS service).

The "Application event identifier" is an identifier within an Application identifier. It is used to notify the Service Data Flow Based Charging Rules Function of such a change within a service session that affects the charging rules, e.g. triggers the generation of a new charging rule.

5.3 Reference points

Editor's note: This clause is planned to contain the description of new and modified reference points.

5.3.1 New Reference points

5.3.1.1 Gx reference point

The Gx reference point enables the use of service data flow based charging rules such as counting number of packets belonging to a rate category in the IP-Connectivity Network. This functionality is required for both offline and online charging.

The Gx reference point supports the following functions:

1. Initialisation and maintenance of connection
2. Request for Charging Rules (from TPF to CRF)
3. Provision of Charging Rules (from CRF to TPF)
4. Termination of PDP context (from TPF to CRF)
5. Removal of Charging Rules (from CRF to TPF)

Initialisation and Maintenance of Connection

A single connection shall be established between a CRF and TPF pair. The connection can be direct, or established via a relay/proxy node. A connection may be redirected to an alternate node.

The relevant interworking peer nodes may be configured, or may be determined through a discovery mechanism. At a failover, commands which have not been successfully received shall be queued to the alternate peer.

The detail specification of the connection establishment and maintenance are for specification in stage 3.

Request for Charging Rules (from TPF to CRF)

At a bearer establishment/modification (PDP context establishment/modification for GPRS), the TPF requests the charging rules to be applied.

The request must identify whether it is an initial request (primary context establishment for GPRS), or a subsequent request (i.e. for GPRS, a secondary PDP context establishment, or a PDP context modification). For an initial request for GPRS, the request must include IMSI, APN, and PDP address information.

An identifier is required to allow the specific instance in the TPF/CRF to be identified for subsequent data exchange. The identifier for the communication must be provided.

The request must provide further information used for the charging rule selection. The request must have an identifier for the bearer, the QoS information, and flow identifier information allocated to the bearer. For GPRS, this information would include the traffic class, and the TFT.

Where the charging rule selection data for a bearer is modified, the TPF sends the request to the CRF indicating it is for a bearer modification, and providing the modified data.

Provision of Charging Rules (from CRF to TPF)

The CRF sends the charging rule information to be applied in the TPF. This may be a response to a Request for Charging Rules, or it may be unsolicited.

The charging rule provision includes information about the instance it relates to (i.e. identifier for the relevant CRF/TPF instance), charging mechanism (online/offline), volume- or time-based charging indication, termination action, charging key, service data flow filter(s), and precedence.

The service data flow filters are specified separately for the uplink and downlink direction.

Note: A charging rule may provide information for service data flows for one direction, or for both directions.

Termination of Bearer (from TPF to CRF)

The TPF indicates to the CRF that a bearer is terminated.

The bearer termination includes information to identify the instance it relates to (i.e. an identifier for the relevant CRF/TPF instance), and an indication of the bearer being removed (the PDP context in the case of GPRS). The termination also indicates if this is the last bearer for that TPF/CRF instance.

Removal of Charging Rules (from CRF to TPF)

The CRF sends an order to the TPF to remove one or more charging rules.

The charging rule removal identifies the user it relates to (i.e. an identifier for the relevant CRF/TPF instance), and further identifies the specific charging rules to be removed.

Editor's note(ii): The functional relationship of the Gx function and further existing interfaces (e.g. the RADIUS-interface of the GGSN defined in TS 29.061) has to be studied and specified.

5.3.1.2 Gy reference point

The Gy reference point allows credit control for service data flow based online charging. The functionalities required across the Gy reference point use functionalities and mechanisms specified for the release 5 Ro interface.

5.3.1.3 Gz reference point

The Gz interface enables transport of service data flow based offline charging information.

For GPRS the relationship of the Gz interface and the existing Ga interface is FFS.

5.3.1.4 Rx reference point

The Rx reference point enables transport of information (e.g. dynamic media stream information) from the application function to the charging rules function. An example of such information would be filter information to identify the packet flow.

5.3.2 Existing reference points

The functionalities across the reference points described in this clause are not intended to be modified within the context of the concepts specified in this TR.

The Ro and Rf interfaces are specified for release 5 in TS 32.200 and TS 32.225.

The Gc interface is specified by TS 23.078 and TS 29.078.

5.3.3 Rx/Gx functions and SBLP usage

Dynamic media stream filter information for QoS policy and charging correlation may be provided to the GGSN via the Gq and Go interfaces. This is described in TS 23.207 and TR 23.917.

Dynamic and static media stream filter information for charging (data for the charging rules) may be provided to the Traffic Plane Function via the Rx and Gx interfaces. This is described in this TR.

These two functions are independent and thus can be provided separately.

6 Message Flows

Editor's note: This clause is planned to contain the description of new and modified information flows.

Annex A: Overall architectural impacts of IP flow based charging

A.1 GGSN in HPLMN

One of the underlying drivers for the IP flow charging work is to permit greater flexibility in PS domain charging, and, to control this flexibility in the HPLMN. This is a fairly fundamental change from the concepts that lead to development of the CAMEL 3 standards (which provide the capability for pre-pay charging on the SGSN) and some aspects of the IMS architecture (eg P-CSCF and I-CSCF).

This movement towards charging in the "GGSN arena" rather than "charging at the SGSN" leads to a few questions:

a) is all the information that the SGSN places on the S-CDR available at the GGSN? If not, what is missing, is it important, and, can GTP be upgraded to provide it to the GGSN?

b) when this information is passed to the GGSN, can it then be made available as extra Radius parameters?

c) does this information need to be sent on the Gx and/or Gy and/or Gz interfaces?

A.2 Comparison of S-CDR and G-CDR fields

A.2.1 S-CDR information missing from G-CDR

The following fields are present in the S-CDR but absent from the G-CDR

- Served IMEI
- MS Network Capability
- LAC/RAC/CI at "record opening"
- Access Point Name Operator Identifier
- System Type
- CAMEL information
- RNC unsent data volume

These parameters are analysed further in the following subsections.

A.2.2 Served IMEI

This information is useful for many operational/statistical purposes within the HPLMN. Examples might include checking whether the SIM-IMEI combination "is correct"; which brands of mobile generate what proportion of revenue streams and/or access particular types of services; etc.

Hence it is recommended to provide the IMEISV to the GGSN for transparent transfer within the GGSN to the G-CDR and/or Radius attribute. This means the addition of an optional parameter to the Create PDP Context Request message.

Note that the IMEISV should be provided rather than just the IMEI because the SV information has some value, and, IMEISV is as equally easy for the SGSN to obtain as the IMEI.

A.2.3 MS Network Capability

This is the "core network" part of the mobile's classmark. Review of 24.008 shows that most of the really interesting information for the HPLMN is contained within the Radio Classmark information and not within the MS Network Capability. However, the Radio Classmark information is not included on the S-CDR.

Hence statistical information gathering (such as, what proportion of UK data traffic is carried by mobiles that support the PCS 1900 spectrum) has to be gathered from analysis of IMEIs rather than analysis of the Classmark field.

Hence, provided IMEISV is sent to the GGSN, this field need not be sent to the GGSN.

A.2.4 LAC/RAC/CI at "record opening"

Various tariffs can be imagined that use cell ID information (eg a home cell tariff, whereby, if the context is opened in your home cell, a certain volume of data is charged at a lower rate). Statistical information gathering is also performed on a per cell basis.

Hence knowledge of the "full" cell ID at the GGSN would be useful.

Note that the "full" cell ID includes the MNC and MCC – but these fields have recently been added to R'97 and R'99 GTP. During the debate on this topic, it might have been argued that the 3G-SGSN did not know the Service Area Code where the mobile was activating the PDP context. However, this seems to be incorrect, because study of RANAP shows that the RNC is required to add the mobile's current SAI to every Direct Transfer message sent to the SGSN,

There may be some concerns about sending cell-ID information between networks, however, it may well already be sent in the inter-operator TAP records! Also, as a "ball park figure", 90% of subscribers are in their home network and 10% are roaming abroad, and the main usage of this field would be for the 90% of subscribers in their HPLMN.

So, it seems useful to add CGI/SAI information into the GTP signalling.

Further complexity arises however from the phrase "at record opening". In both SGSN and GGSN, it is possible to raise partial CDRs. A "partial CDR" is potentially generated every 15 minutes and reduces the fraud risks associated with only generating a full CDR after many mega bytes have been sent on a PDP context that has been open for several days. From reading 32.215 it seems that the Cell ID needs to be inserted into the S-CDR every time a partial CDR is opened.

Full support of the Cell ID in Partial G-CDRs appears difficult, however, a useful compromise would seem to be to add CGI/SAI information to all GTP messages that can be sent by the SGSN as a result of receiving a RANAP Direct Transfer message. When the mobile is using the Gb interface, the SGSN should add the CGI to these messages.

Hence it is recommended to add CGI/SAI as an optional parameters in the following GTP messages:

- Create PDP Context Request
- Update PDP Context Request

Whether or not the CGI/SAI is included by the SGSN should be controlled by the SGSN operator according to the PLMN-ID of the GGSN.

A.2.5 Access Point Name Operator Identifier

Section 14.13 of 3GPP TS 23.060 states that this field is part of the APN and that the APN is used to identify the GGSN. As such, it is logical that this field is included on the S-CDR.

However, there appears to be absolutely no need to transfer this field to the GGSN.

A.2.6 System Type

On the S-CDR, this indicates whether the SGSN serves 2G or 3G cells. There is no code point for a combined 2G/3G SGSN, and no indication as to whether or not the combined SGSN has separate 2G and 3G Routeing Areas!

It is recommended to add an "SGSN type" information element to the following GTP messages:

- Create PDP Context Request
- Update PDP Context Request

The contents of the "SGSN type" information element should be able to encode the following information, and permit future backwards compatible extension:

- 2G only SGSN

- 3G only SGSN
- Combined 2G/3G SGSN with all 2G cells in separate Routeing Areas to 3G cells
- Combined 2G/3G SGSN with some 2G and 3G cells in the same Routeing Area

Future additions might be needed to add in UMTS FDD/TDD differentiation, or if new Radio Access Technologies are adopted in the future.

Note that this "SGSN type" is different to the current "System type" field on the S-CDR. Whether or not the "System type" field on the S-CDR should be updated is FFS.

A.2.7 CAMEL information

This needs some further study.

A.2.8 RNC unsent data volume

If this information is useful to an SGSN, then it should be passed to the GGSN. In doing so it needs to be supplemented by the "2G SGSN unsent data volume". Probably the unsent data volume could be accumulated by the SGSN and sent to the GGSN at PDP context release/inter SGSN change.

However, as the value of sending this information from the RNC to the SGSN is as yet unclear, it is not yet proposed to add this information into the GTP signalling.

A.3 RADIUS attributes

With the provision of the above information to the GGSN, it is recommended that the following RADIUS attributes are added to the appropriate RADIUS messages:

- IMEISV
- CGI/SAI
- SGSN type

Annex B: Change history

Change history							
Date	**TSG #**	**TSG Doc.**	**CR**	**Rev**	**Subject/Comment**	**Old**	**New**
2002-11					First draft		0.1.0
2003-02					Output version from SA2#29. Changes proposed in S2-030408rev2, S2-030409 and S2-030410are implemented. Primarily architecture requirements and descriptive text added.	0.1.0	0.2.0
2003-03					Updated with approved contributions from SA2#30 S2-030947, S2-030951, S2-030952, S2-030953r3, S2-030954, and S2-030851 Some editorial fixes (formats, blanks lines, etc)	0.2.0	0.3.0
2003-04					Updated with approved contributions from SA2#31 S2-031523, S2-031524, S2-031525, S2-031526, S2-031608	0.3.0	0.4.0
2003-04					Updated with minor editorial changes	0.4.0	0.4.1
2003-05					Updated with approved contributions from SA2#32	0.4.1	0.5.0

					S2-032145, S2-032195 (was S2-032140 rev 1)		
2003-07					Updated with approved contributions from SA2#33 S2-032581, S2-032715, S2-032716, S2-032717 Term "service flow" changed to "service data flow" throughout. Term "service filter" changed to "service data flow filter" throughout.	0.5.0	0.6.0
2003-07					Addditional editorial changes from "service flow" to "service data flow"	0.6.0	0.6.1
2003-08					Updated with approved contributions from SA2#34 (Brussels): S2-032989, S2-033155, S2-033156, S2-033157, S2-033158, S2-033159, S2-033257 (S2-033160 rev 1), S2-033161 Editorial fixes: - section 5.2.1 merged into what was 5.2.3. Sections 5.2.2 through 5.2.6 then renumbered to one lower eg 5.2.2 -> 5.2.1. - Introduced TPF in abbreviations - Fixing some paragraphs to use correct style	0.6.1	0.7.0
2003-09					First presentation for information to SA #21 plenary	0.7.0	1.0.0
2003-10					Updated with approved contributions from SA2#35 (Bangkok): S2-033506, S2-033507, S2-033508, S2-033511, S2-033512, S2-033759, S2-033780. Editorial improvement to introduce term CRF. Other minor editorial corrections.	1.0.0	1.1.0